# SCIENCE

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# THE NATIONAL ROSTER OF SCIENTIFIC AND SPECIALIZED PERSONNEL: A PROGRESS REPORT

By Dr. LEONARD CARMICHAEL

PRESIDENT OF TUFTS COLLEGE, DIRECTOR OF THE NATIONAL ROSTER OF SCIENTIFIC AND SPECIALIZED PERSONNEL

IN a previous communication (SCIENCE, August 16, 1940, Vol. 92, No. 2381, pages 135–137) a preliminary report was made of the plans for the National Roster of Scientific and Specialized Personnel. The roster, although still far from complete, is now actually in use. Each week it is called upon by an increasing number of defense agencies to provide lists of names of individuals with special qualifications. As stated before the roster is jointly administered by the National Resources Planning Board and by the United States Civil Service Commission.

The general questionnaire, the projected form of which was described in the first report, has been made. This questionnaire is broken into 30 elements, the information asked including: (1) Name; (2) Date of birth; (3) Place of birth; (4) Citizenship status; (5) Marital status; (6) Race and sex; (7) Military service; (8) Reserve membership; (9) Foreign language proficiency; (10) Federal service; (11) Federal Civil Service examinations taken; (12) Foreign travel and residence; (13) Physical condition; (14) Height and weight; (15) Names of persons for reference; (16) College and university education, including the special honors received and membership in honorary academic or scientific societies; (17) Important hobbies; (18) List of significant full-time positions held; (19) The five most important fields of specialization listed in order of significance (these five fields are taken by the individual filling out the questionnaire from the technical checklist described below); (20) The individual's

own naming of his professional field (that is, "radio physicist" or "electrical engineer"); (21) The individual's competence with unusual apparatus; (22) Part-time and temporary positions held; (23) List of publications, patents, etc.; (24) Description of research in progress; (25) Description of restricting conditions making part-time or full-time government work difficult; (26) Disadvantage to important research if the individual is called for service; (27) Committees and research organizations with which the individual is associated; (28) Society membership; (29) General field in which the individual would be of special service to the government; (30) Agency to be applied to for release if the individual is to be queried concerning possible government service.

The questionnaire including these items was formulated after consultation with many academic and government specialists in the construction of such instruments. Supplementing the general questionnaire, a series of technical checklists has been drawn up and is still being formulated in special fields. At the present time checklists have been devised and mailed in the following fields: aeronautical engineering; anatomy; anthropology; automotive engineering; bacteriology, immunology, and pathology; botany; chemistry; chemical engineering; civil engineering; electrical engineering; forestry; genetics; geography; geology; heating, ventilating, air conditioning, and refrigeration engineering; history and political science; mathematics; mechanical engineering; mining and metallurgical engineering; physics and astronomy; physiology; plant pathology; horticulture, and agriculture; psychology; sociology; statistics; testing materials; and zoology. These checklists have been devised by specialists in each field and in many instances their development has been much more than a mere mechanical operation. For example, Dr. Carl Brigham, of Princeton University, the official representative of the Social Science Research Council, working with a series of economists, has brought out a basic checklist in economics which is supplemented by a checklist in statistics and in raw materials. These combined lists are even said by certain economists to be the most effective analysis of that field so far devised. Dr. John S. Nicholas, of Yale University, the official representative on the roster from the National Research Council, working with a whole series of scientific societies has done really creative work in making analyses of special sciences which are both logical and practical from the standpoint of the placement purposes of the roster. Dr. William H. Cowley, president of Hamilton College, representative of the American Council on Education, and Dr. Waldo G. Leland, representative of the American Council of Learned Societies, have also contributed much work to the development of the roster.

It is too early yet to give an estimate of the complete returns received in relation to the number of questionnaires sent out. The first field circularized, that of physics and astronomy, may give an index of the returns that are to be expected. In all 7,424 questionnaires were mailed out in this field, and so far 6,045 of these have been returned fully filled out.

The complete operation of the roster under the able direction of its executive officer, James C. O'Brien, promotions officer of the U. S. Civil Service Commission, and of the office of the roster under the chief of the project, W. E. Workmaster, has been most effective during the months of its existence. The fundamental problem of the whole staff of the roster has been the completion of a series of intricate steps which must be taken in each field. First, the technical checklist has to be drawn up. Second, the mailing lists must be secured. Third, procedures must be developed by means of which the qualitative information in the questionnaire can be reduced to quantitative terms. This latter work has required the development of some elaborate new techniques. For example, the roster has developed the work of certain other federal agencies in devising a plan for numbering the questionnaires as they are returned. This operation involves the use of what we call the alpha numerical index. Briefly, this index makes it possible to assign each individual a questionnaire number such that his alphabetical place and his numerical place will be identical in the total list of questionnaires when the project is complete. That is, the files may be searched for "John X. Doe" either under the D's, the Does, the John Does, the John X. Does, or under a special number. In the case of John X. Doe this number would be 1,882,005. All individuals before John X. Doe in the alphabet would have lower numbers and all above him would have higher numbers. The assigning of each number is accomplished by the use of large log books which have been prepared to make this procedure possible.

Reducing the qualitative information concerning geographical area, linguistic ability, educational level and the like has also required the development of many code sheets in the office of the roster. For example, the geographical regions of the world have been divided into what seemed to be the 999 most important regions from Crown Princess Martha Land to the South Felix Islands. Benjamin Wermiel and Robert Shosteck, of the staff of the roster, have been especially active in the organizational work that has made possible the development of these code lists.

It is of course obvious that all the qualitative information in the questionnaire can not be reduced to quantitative terms. The names given as references can not of course be placed on an individual's punch card nor can the bibliography or patents of the individual be so recorded. For these reasons as well as

for others the fundamental operation of the roster involves only the use of the cards to a certain point. As soon as the appropriate cards are sorted out the questionnaires from which they were made are once again taken from the files. The agent of the defense agency which has asked for some particular group of individuals is then allowed to go through the basic questionnaires of the individuals who fit his needs.

Actually in completed form each individual is allotted five 80-column punch cards in the catalog. These cards are used to record the basic information of the questionnaire and the special information secured from the technical checklists. The large number of cards is necessary because the individual's special skills are punched not only in the order in which he gives them but also with what the individual characterized as his second skill punched as the first skill, and so on. The last card of the five is used to provide the full name of the individual in alphabetical rather than numerical code, his roster number, and some other identifying characteristics. By the use of this last card it is possible to print automatically a list of names of those selected. For example, if a request comes to the roster for physicists who have specialized in the study of ultra high frequency radio circuits, of a certain age, in a special army corps area, it is possible to set the selecting machine in such a way that a list will be printed of these individuals and of no others.

Those connected with the administration of the roster are increasingly impressed by the fact that the list that is being developed not only is invaluable in the present emergency period, especially in those fields in which real shortages of trained personnel have already developed, but also that it has potentialities for normal periods as well. If Civil Service procedures are a little modified the recruitment of technical personnel for the government might well involve the use of the roster to the real advantage of the government. That is, if mailing lists could be secured of properly trained physicists when an opening occurred in this field at the Bureau of Standards it would be possible by sending out a card of information to tell all individuals in this field in the country that an examination was about to be held. Similarly, after the present emergency is over slight adaptation would be required to make the roster available as an agency to assist in the proper recruitment of college faculties, personnel of industrial research organizations and the like. For these reasons every effort has been made to plan the roster so that it can be kept up to date as a continuing census of America's specialists.

Those concerned in the development of the roster have been strikingly impressed by the patriotism of America's scientists as displayed in the practical work of developing the roster. Busy men engaged in important work have almost without exception been willing to undertake the difficult problem of assisting in the development of the particular segment of the roster related to their own special fields. There is no doubt in the minds of those who have been associated with this project from the first that America's scientists are actively willing to serve the nation. Above all there seems to be little doubt that America's greatest resource in the difficult period that lies ahead is the brain power—if a non-psychological term may be used—of its highly trained scientists and other specialists. It seems impossible to the present writer as he views the growing lists of the roster that the rest of the world together could provide a register of highly trained men comparable to this list of citizens of the United States.

# REPORT OF THE PRESIDENT TO COUNCIL OF AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

By Dr. ALBERT FRANCIS BLAKESLEE

CARNEGIE INSTITUTION OF WASHINGTON, DEPARTMENT OF GENETICS, COLD SPRING HARBOR, N. Y.

TO-DAY is the first opportunity to express my appreciation to the council for their confidence in electing me president of the American Association for the Advancement of Science. I realize that responsibilities go with any office and have tried therefore to do some thinking about the problems of the association. Perhaps the chief value, if any, of this report which I have prepared will lie in its offering a precedent with expectation that some future president will give birth in *his* report to a bright idea, and bright ideas are precious. In considering what might be said concerning the state of the association I began to realize that the American Association for the Advancement of Science occupies a unique position. Organizations with restricted membership like the National Academy of Sciences with its related National Research Council serve a purpose, as do also the various societies devoted to special fields of science. There is no other democratic organization in the world, however, covering the whole field of science which compares with the American Association in the number of scientists which it serves. The present membership is slightly over 21,000. The first table of the Appendix shows the

[1] Philadelphia, December 27, 1940.

distribution of members in the different sections. The percentages may furnish a rough criterion of the relative proportion of potent scientists in the different groups in this country, if we make the natural assumption that potent scientists will in large measure be members of the association.

The 179 affiliated and associated societies have a total membership, including duplicates, of over 900,000. Most of these societies are affiliated with the association and are entitled to elect representatives to the council.

Its democratic organization and wide representation give to the association great and peculiar opportunities, I believe, in the way of synthesis and integration. Its aim should certainly emphasize service to science, broadly considered, not only to its own members and to American science but to science throughout the world. At the present time it has a special obligation to uphold the traditions of freedom of thought and untrammeled search for truth, which in a large part of the world are no longer possible. With the Association for Advancement of Science in Britain, which is so valiantly leading in the present struggle for freedom, our association has established friendly relations and under a reciprocal arrangement the principal executive officers of each association are elected honorary members of the other association. I believe these bonds with the British Association should be strengthened and something more material than an honorary listing of names should be done by our organization. Corresponding and foreign members of many organizations automatically receive their official publications. I believe we should be similarly generous with our publications to our honorary members, the number of which from foreign countries might well be increased. In 1939 there were twenty-nine officers and members of the Council of the British Association listed in our summarized "Proceedings" as honorary members. For 1940 there were also twenty-nine, all but six of whom were duplicates of the 1939 listing. I suggest that SCIENCE, for example, be presented to these honorary members from the British Association during their term of office, as well as to all their past presidents. The expense involved should not be great in comparison with the service rendered. It should be possible to make arrangements with The Science Press to provide these complimentary subscriptions at the cost of running off extra copies after the composition and printing overhead expense had been cared for. Such extra copies could be furnished for not over two dollars each, from estimates of the editor of SCIENCE. If the British Association has the same number of past presidents as does our association (fourteen) the total cost of sending SCIENCE to the principal officers and past presidents of the British Association should not be over $86. Later, if the scheme suggested proved of sufficient service, similar though perhaps less extensive arrangements might be made with science associations in other countries when freedom of intercourse throughout the world has been restored.

The association has done a service in its relations with academies of science, and has cooperated with the work of junior academies and junior science groups. This year the association elected to honorary junior membership for the one year twenty-seven young people nominated by affiliated academies. I suggest the desirability of the association giving each junior honorary member a year's subscription to one of the association's journals, if arrangements can be made with the editor of The Science Press to provide them at the cost of running off extra copies. Such a plan might turn out to be of ultimate financial profit to the association in training up new members, but its primary object should be the advancement of science. The great problem in the advancement of science, I believe, is to catch the exceptional man young and to give him encouragement and exceptional opportunities to exercise his exceptional talents in research, education or administration of science. The relations established between the association and junior academies and science groups is a step in the right direction, but the problem appears to need continuing study on the part of the association.

I have suggested some perhaps minor ways in which the influence and service of the American Association might be increased here and abroad. Its influence depends in large measure upon the size and quality of its membership and upon its financial stability.

The publication problem is a serious one with almost all organizations. It is becoming increasingly so in this country, due to the present world war, and if we become more deeply involved in the conflict the problem may become critical. During the recent depression in this country membership in the association dropped from a peak of, roughly, 20,000 in 1931 to around 18,000 in 1935 and 1936, although it has gradually increased since the latter date. This fact shows that the membership is influenced by the economic conditions of the country. If the membership should be cut in half, or even suffer a greater reduction that might readily be brought about by an unfavorable change in world conditions, the association would be in an extremely unfortunate financial situation. A number of members of the association have called my attention to arrangements which they understood had been made for the ultimate disposition of SCIENCE and *The Scientific Monthly* and have expressed concern as to the effect which these arrangements might have upon the association's finances. I believe I should state the situation from the standpoint of the association as I understand it. The association is under serious obligations for an uncertain future since it

is bound by a contract with the editors of The Science Press to pay them or their estate an annuity upon their death or relinquishment of the journals. The annuity, which is to be continued for a ten-year period, is one half the net average income of the five years preceding such relinquishment. The probable total amount that the association will be obligated to pay during the ten-year period is estimated to be approximately $150,000. The contract has no release clause and the association would have to depend upon its invested capital to pay the annuity if the membership and subscriptions should decrease to a point where they would not suffice to pay the annuity plus the editorial costs of the journals. Tabulations regarding the journals and the annuity contract are given in the adjoining Appendix.

From the vantage point of more than fourscore years Dr. Cattell can look back on a long and fruitful career of activity in scientific management and publication. He has been a member of the executive committee of the association, or its earlier equivalent the committee on policy, for about forty years and has been chairman of the executive committee since the beginning of 1925. He has been owner and editor of SCIENCE for forty-five years. He has thus had much to do in guiding the policies of the association and has controlled the policies of its official journals since before their connection with the association. He has rendered the association a great service, especially in the early stages of the publication of SCIENCE when initiative and even daring made his venture in taking over a financially unprofitable journal successful. As an editor he has been resourceful in securing a high grade of material for the journals and discriminating in accepting the manuscripts which have been submitted. The association will probably find it extremely difficult, if not impossible, to secure in one man and his wife the equal to Dr. and Mrs. Cattell in efficient business management and editorial control of its publications. But this is a problem the association must face when Dr. Cattell feels it necessary to relinquish his control of SCIENCE and *The Scientific Monthly*. Not only must the association secure outstanding editorial ability but it also must determine publication policies.

It is the living active mind of Cattell as editor which has been an asset to the journals, and the association could afford to pay generously for his editorial services, but when these services terminate it is questionable how much will be left in the way of assets which the association does not already possess in its own membership. Since nearly 90 per cent. of the combined circulation of the journals is due to member subscriptions it is a question how much value to the association there will be in the names of the journals and the so-called good-will that goes with them when the present editor can no longer guide them.

I am presenting to the council, by means of tabulations in the Appendix, some facts perhaps not generally known and am presenting a problem, for which I admit I do not have the answer. I am suggesting that it would be appropriate to have a resolution from the council for the appointment of a committee which would give careful and sympathetic study of the problem of the journals of the association, including existing contracts, editorial management and the whole policy of publishing journals from the association's standpoint.

(The above resolution was passed upon recommendation of the executive committee, and the president was authorized by the council to appoint the committee. At the request of the presiding president the council later voted that the committee be appointed by the incoming president in consultation with the executive committee.)

I should like to see tried out in an experimental way a plan of having from time to time a general central theme for the annual meeting of the association about which symposia, invitation papers, exhibits and other activities could be grouped. A few such central themes may be suggested.

It is obvious that "Evolution" as a theme would not need to be confined to organic and cosmological evolution, but would prove a fruitful topic of discusssion in all the sections, including evolution of physical and chemical systems, sociology, economics, education, history and philogeny.

"Time" is another central theme which in different ways could be discussed with profit. It could be considered in respect to life span and the effect of aging upon structural and physiological responses in plants and animals as well as upon the composition of human populations and resultant economic conditions. Reaction time, geologic time and time scales in astronomy and geology are only some of the expressions containing the word time which suggest subjects for discussion.

"Sources of Energy" as a central theme might not only interest the physicists and chemists but also the student of plants and animals. Its meaning could be broadened to include social and political systems.

"Temperature" is also a topic of general interest.

"Individuality" is a topic which has interested me personally and about which I may have something to say in my retiring address at next year's meeting. The biologist realizes that no two individual plants or animals are exactly alike and attempts to evaluate the relative rôle of heredity and environmental factors responsible for the differences between individuals. To what extent heredity and environment are factors in

bringing about differences in human behavior is a question of vital importance in education, sociology and other humanistic studies. The anthropologists would be in position to give information regarding the range of variability in the human skeleton and to tell to what extent there are racial types so far as physical form is concerned. The psychologists could discuss tests for intellectual, moral and other mental differences involved in personality; the sociologists and economists, the adjustment of social and economic practice to different personalities. The historical and philological sciences might discuss the relative role of the individual as opposed to the group in history. In the engineering section might come the adaptability tests such as those for motorists and aeroplane pilots. The medical sciences could have something to say about individual differences in susceptibility to disease, response to drugs, color blindness, blood groups and allergy. In agriculture the significance of the exceptional individuals in different systems of breeding, biological races of host and parasite, and the relative importance of genetic methods in comparison with favorable environment in increasing yield in different economic forms are some of the subjects which suggest themselves. In education, subjects which might be worth discussing are the relative emphasis to be placed on method and subject-matter and the relation of mental tests to the educational curriculum. Individual differences may be swamped in averages. The mathematician may give us reliable statistical measurements of individuality. If we change the term heredity without changing greatly its meaning we have in physical and chemical systems a similar conflict of influence between innate characteristics, such as structural arrangement of molecules and the environment, such as temperature. Chemical personality problems are therefore of interest to the chemist.

Such central themes as I have suggested could be developed in symposia, invitation papers and demonstrations in the association's exhibition, and might lead to profitable joint discussions taken part in by different sections, which the association might find it of advantage to publish.

Since "Individuality" is the kernel of democracy, it has been suggested that no better contribution could be made by the American Association than presenting as convincingly as possible the great amount of information available on the occurrence and importance of the individual. The topic of "Individuality" is therefore suggested as a general theme for the Dallas meeting to which the various sections and affiliated societies may make whatever contributions they see fit.

## APPENDIX

GROWTH OF $A_3S$ IN RELATION TO ITS OFFICIAL JOURNALS

1881. SCIENCE founded by Thomas A. Edison

1883. SCIENCE purchased by Alexander Graham Bell

1894. SCIENCE purchased by Dr. Cattell

1895–1920. SCIENCE was printed by New Era Printing Company, who "maintained the same rates for SCIENCE for 25 years."

1896–1907. SCIENCE was published by Macmillan Company, "who assumed the cost in view of the value to them of the advertising space."

In 1900 SCIENCE was made official organ of association.

In 1909 members could receive in place of SCIENCE, *Popular Science Monthly*, name of which was changed to *The Scientific Monthly* in 1915.

From 1900 to 1920 dues were $3.00, and $2.00 was paid by association for each member subscription to SCIENCE or *The Scientific Monthly*.

Since January, 1920, dues have been $5.00 and association has paid $3.00 for each member subscription.

1927. Members allowed to receive a second journal (SCIENCE or *The Scientific Monthly*) at $3.00 rate.

July 28, 1925. Contract signed regarding transfer of SCIENCE to the association at some future date; *cf.* SCIENCE, 64: 342–347, 1926.

December 12, 1938. Contract signed for both SCIENCE and *The Scientific Monthly*. Copy of contract appended.

MEMBERS AND FELLOWS OF THE ASSOCIATION DISTRIBUTED BY SECTIONS
September 1, 1939
(A member may be listed in several sections)

| | Members | Fellows | Totals in Sections | Percentages in Sections |
|---|---|---|---|---|
| Mathematics (A) | 650 | 872 | 1522 | 4.24 |
| Physics (B) | 1517 | 1732 | 3249 | 9.05 |
| Chemistry (C) | 2473 | 2391 | 4864 | 13.56 |
| Astronomy (D) | 346 | 455 | 801 | 2.23 |
| Geology and Geography (E) | 927 | 988 | 1915 | 5.34 |
| Zoological Sciences (F) | 1790 | 2073 | 3863 | 10.77 |
| Botanical Sciences (G) | 1236 | 1975 | 3211 | 8.95 |
| Anthropology (H) | 556 | 392 | 948 | 2.64 |
| Psychology (I) | 977 | 792 | 1769 | 4.93 |
| Social and Econ. Sc. (K) | 783 | 423 | 1206 | 3.36 |
| Historical and Philological Sciences (L) | 240 | 168 | 408 | 1.14 |
| Engineering (M) | 1482 | 1064 | 2546 | 7.10 |
| Medical Sciences (N) | 2856 | 2402 | 5258 | 14.65 |
| Agriculture (O) | 655 | 1122 | 1777 | 4.95 |
| Industrial (P) | 232 | 41 | 273 | 0.76 |
| Education (Q) | 938 | 865 | 1803 | 5.02 |
| No Section | 464 | 4 | 468 | 1.30 |
| Totals | 17,658 | 17,755 | 35,881 | 99.99 |

Membership on September 30, 1940, was 21,067.

CIRCULARIZATION COST AND MEMBERSHIP STATISTICS FOR THE YEAR ENDING SEPTEMBER 30, 1940

| | | |
|---|---|---|
| *Circularization* | | |
| Total circularization cost | | $3,808.00 |
| Number of new members | | 1,618 |
| Cost per new member | | 2.36 |
| (Each new member secured by circularization in 1940 cost that year thirty-six cents more than the $2 share which the association received from the $5 dues. Since the average duration of a membership is about seven years the circularization of last year should ultimately yield a net profit.) | | |
| *Membership* | | |
| *Gain in memberships* | | |
| Reinstatements | | 27 |
| *New Members* | | |
| From circularization | 1,618 | |
| At winter and summer meetings | 47 | |
| Office correspondence and other sources | 363 | |
| From circularization prior years | 140 | 2,168 |
| Total gain | | 2,195 |
| *Loss in memberships* | | |
| Dropped for non-payment of dues | | 470 |

| | |
|---|---|
| Resignations | 611 |
| Deaths | 242 |
| Total loss | 1,323 |
| Net gain for fiscal year 1940 | 872 |

Total circularization cost for five years ending September 30, 1940 ..... $19,490.00

Note: Memberships are expressed in even thousands and include some names in arrears.

| Year | Memberships | Extra membership above number in 1900 | Year | Memberships | Extra membership above number in 1920 |
|---|---|---|---|---|---|
| 1881–92 each year | 2,000 | | | | |
| 1893 | 2,000 | | | | |
| 1894 | 2,000 | | | | |
| 1895 | 2,000 | | | | |
| 1896 | 2,000 | | | | |
| 1897 | 2,000 | | | | |
| 1898 | 2,000 | | | | |
| 1899 | 2,000 | | 1920 | 11,000 | .... |
| 1900 | 2,000 | .... | 1921 | 12,000 | 1,000 |
| 1901 | 3,000 | 1,000 | 1922 | 12,000 | 1,000 |
| 1902 | 4,000 | 2,000 | 1923 | 12,000 | 1,000 |
| 1903 | 4,000 | 2,000 | 1924 | 13,000 | 2,000 |
| 1904 | 4,000 | 2,000 | 1925 | 14,000 | 2,000 |
| 1905 | 4,000 | 2,000 | 1926 | 14,000 | 3,000 |
| 1906 | 4,000 | 2,000 | 1927 | 15,000 | 4,000 |
| 1907 | 5,000 | 3,000 | 1928 | 16,000 | 5,000 |
| 1908 | 6,000 | 4,000 | 1929 | 18,000 | 7,000 |
| 1909 | 8,000 | 6,000 | 1930 | 19,000 | 8,000 |
| 1910 | 8,000 | 6,000 | 1931 | 20,000 | 9,000 |
| 1911 | 8,000 | 6,000 | 1932 | 19,000 | 8,000 |
| 1912 | 8,000 | 6,000 | 1933 | 19,000 | 8,000 |
| 1913 | 8,000 | 6,000 | 1934 | 19,000 | 8,000 |
| 1914 | 8,000 | 6,000 | 1935 | 18,000 | 7,000 |
| 1915 | 9,000 | 7,000 | 1936 | 18,000 | 7,000 |
| 1916 Est. | 10,000 | 8,000 | 1937 | 19,000 | 8,000 |
| 1917 | 10,000 | 8,000 | 1938 | 19,000 | 8,000 |
| 1918 | 11,000 | 9,000 | 1939 | 20,000 | 9,000 |
| 1919 | 11,000 | 9,000 | 1940 | 21,000 | 10,000 |
| Approximate total annual memberships above number in 1900 for period (1901–1919) ..... | | 95,000 | Approximate total annual memberships above number in 1920 for period (1921–1940) .. | | 117,000 |

STATISTICS REGARDING ANNUITY FOR SCIENCE AND SCIENTIFIC MONTHLY ON BASIS OF CONTRACT GOING INTO EFFECT AT END OF 1940

| | | |
|---|---|---|
| Estimated Total net income for past 5 years ..... | approximately | $150,000* |
| Estimated Average annual net income to publishers for past 5 years on which annuity will be based ..... | approximately | $ 30,000 |
| Yearly annuity to be paid by Association for 10 years ..... | approximately | $ 15,000 |
| Total annuity for 10 years ..... | approximately | $150,000 |

* From statement of the editor of The Science Press, the total income for the four years, 1936 to 1939, was $120,507.94 for SCIENCE and $7,831.23 for *The Scientific Monthly* making a yearly average of $32,084.80 for the two journals for the four year period.

CIRCULATION DATA FOR SCIENCE AND THE SCIENTIFIC MONTHLY FROM AMERICAN NEWSPAPER ANNUAL AND DIRECTORY—N. W. AYER AND SONS—AND AUDIT BUREAU OF CIRCULATIONS

| Year of Circulation | SCIENCE | *Scientific Monthly* | Ratio of SCIENCE to *Scientific Monthly* |
|---|---|---|---|
| 1926 | 10,392 | 7,466 | 1.4 |
| 1927 | 10,757 | .... | .. |
| 1928 | 11,851 | .... | .. |
| 1929 | 13,150 | .... | .. |
| 1930 | 13,337 | 9,208 | 1.4 |
| 1931 | 13,801 | 8,939 | 1.5 |
| 1932 | 13,337 | 8,415 | 1.6 |
| 1933 | 12,202 | 7,397 | 1.6 |
| 1934 | 12,465 | 7,231 | 1.7 |
| 1935 | 12,606 | 7,323 | 1.7 |
| 1936 | 13,044 | 7,679 | 1.7 |
| 1937 | 13,252 | 7,927 | 1.7 |
| 1938 | 13,558 | 8,133 | 1.7 |
| 1939 | 14,081 | 8,559 | 1.6 |
| 1940 | 14,423 | 8,972 | 1.6 |

MEMBER AND NON-MEMBER SUBSCRIPTIONS TO SCIENCE AND THE SCIENTIFIC MONTHLY. 1940

| | Circulation June 30, 1940 (A.B.C. Record) | Member subscriptions Sept. 30, 1940 (AAS office record) | Non-member circulation | Per cent. of circulation going to AAS members |
|---|---|---|---|---|
| SCIENCE ..... | 14,423 | 13,100 | 1,323 | 90.83 |
| *Scientific Monthly* . | 8,972 | 7,600 | 1,372 | 84.71 |
| Combined ..... | 23,395 | 20,700 | 2,695 | 88.48 |

On September 30, 1940, paid membership was 19,815; members taking both journals was 883 (4.5 per cent.).

## CONTRACT REGARDING SCIENCE AND THE SCIENTIFIC MONTHLY

THIS INDENTURE made this twelfth day of December, 1938, between JAMES MCKEEN CATTELL and JOSEPHINE OWEN CATTELL, his wife, co-partners trading under the registered trade name THE SCIENCE PRESS, both residing at Garrison, New York, grantors, and THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (a corporation organized and existing under the laws of the Commonwealth of Massachusetts), hereinafter referred to as the Association, witnesseth:

WHEREAS on July 25, 1925, the said J. McKeen Cattell, acting on behalf of said partnership, entered into an agreement with said Association providing that the journal "Science" should become the property of the Association under certain conditions; and

WHEREAS, subsequently, on December 25, 1936, said James McKeen Cattell, acting on behalf of said partnership, made an offer for the sale and transfer to the Association of the journal, "The Scientific Monthly," which offer was accepted by said Association on June 25, 1937; and

WHEREAS the parties hereto have agreed to modify the terms of said agreements so as to provide for the present transfer of title to both of said journals to the Association, and to provide for a somewhat different method of payment for said journals by the Association;

NOW THEREFORE THIS INDENTURE WITNESSETH that the grantors, in consideration of the agreements herein contained, and for and in consideration of the sum of ten dollars ($10.00), receipt of which is hereby acknowledged, hereby sell, transfer and convey the absolute and unencumbered ownership of said journals "Science" and "The Scientific Monthly," together with their good will and all things appertaining to them to said Association, its successors and assigns forever.

In consideration of such conveyance said Association agrees to pay, in equal shares, to said James McKeen Cattell and Josephine Owen Cattell (or to her estate in case of her death) a total sum of three dollars ($3.00) per year for every annual member of said Association whose annual dues are paid and for every

fifty-year member and for every life member, so long as said grantors continue to control the editing and publication of said journals.

Upon the death of said James McKeen Cattell, in which event the control of the editing and publication of said journals by the grantors shall terminate, or upon the voluntary relinquishment by the grantors to the Association of such control of either or both of said journals, said Association shall pay each year in equal quarterly installments for a period of ten years to said James McKeen Cattell and said Josephine Owen Cattell, in equal shares, or upon the decease of either of them to his or her estate, a total sum equal to one-half of the average of the annual excess of receipts over costs in the conduct of each said journals so relinquished for the five calendar years immediately preceding the date of such death or voluntary relinquishment of control. For the purpose of determining the amount of the payments to be made for each of said journals so relinquished, the receipts from and costs of the editing and publication of it shall be determined from the books of account kept and used in conducting the business of the editing and publication of said journals, to which books the representative of said Association shall have access at any time. Said receipts shall include the payments made by said Association to said James McKeen Cattell and Josephine Owen Cattell for the purchase of said journals and in addition receipts from all subscriptions, advertisements and all other income incident to the publication of each of said journals. The cost of editing and publication of said journals shall not include any payment for services rendered to said journals by said James McKeen Cattell or Josephine Owen Cattell. In arriving at the cost of editing and publication, the outlays of the said grantors for office rent, business management and like overhead expenses shall be prorated in proportion to the expense of the several publications published by them, and the proportion thereof chargeable on that basis to each of said "Science" and "The Scientific Monthly" shall be deemed part of the cost of the editing and publication thereof.

Complete and absolute control of all problems and policies of the editing and publication of each of said journals shall remain with said grantors until the decease of James McKeen Cattell, in which event such control shall terminate, or until the voluntary relinquishment by said grantors of the control of each of said journals to the Association, and during that time said grantors shall retain all receipts from every source incident to the publication of such journals, and the said grantors do hereby agree to edit and publish each of said journals and to pay all costs of such editing and publication. Said grantors further agree that during such period they will cause to be furnished to each member of the Association in good standing and to each fifty-year member and to each life member a copy of each issue of either said "Science" or "The Scientific Monthly," as shall be designated by said Association; or a copy of each issue of both journals to any member of said Association for any year upon the payment by said Association to the grantors of an additional sum of $3.00.

Upon the death of said James McKeen Cattell or upon the voluntary relinquishment of control of the editing and publication of either or both of said journals by said grantors, the Association shall be entitled to all outstanding accounts not yet due to each of said journals so relinquished and shall be liable for all outstanding obligations of each of said journals so relinquished that are not yet due. Any accounts receivable and past due at the time of the relinquishment of control of the editing and publication of either or both of said journals so relinquished shall be retained by said grantors, who shall also retain any personal property used in the editing and publication of said journals.

Upon the death of said James McKeen Cattell or upon the voluntary relinquishment of control of the editing and publication of either or both of said journals by said grantors, the said grantors shall retain all sums received by them from the Association and all sums representing subscriptions to said journals paid in advance, provided however that an adjustment shall be made as if the death of the said J. McKeen Cattell or the voluntary relinquishment of the management and control of said journals, as the case may be, had occurred on July 1 of the year in which such death or relinquishment shall actually occur. Copies in stock of back issues of said journals shall belong to said Association. Said grantors agree that in case they decide to relinquish control of the editing and publication of said journals during the lifetime of said James McKeen Cattell, they will give to the Association three months' written notice of their intention to do so.

The Association agrees that upon the voluntary relinquishment of the control of the editing and publication of said journals by said grantors, or upon the death of said James McKeen Cattell, it will continue the then existing arrangements for editing, publishing and printing said journals for three months or for such longer period as may be agreed upon after such relinquishment or death, and so long and in so far thereafter as is consonant with the interests of said Association.

Should the average purchasing value of the dollar during any calendar year decrease by as much as 10 per cent. from its value in the year 1938, as determined by standard indices, an adjustment shall be made increasing in equal ratio the payments provided

for in this agreement, the increase to continue so long as the purchasing value of the dollar shall remain by as much as 10 per cent. below that in the year 1938.

In case the parties hereto disagree in respect to the meaning, intent or execution of any of the provisions of this indenture, the question at issue shall be submitted to three arbitrators to be appointed within three months of the date of such disagreement, one to be appointed by said grantors or their personal representatives, one by said Association and a third by the arbitrators so chosen. In case one of the parties hereto fails to appoint an arbitrator within the three months' time limit and the other party does appoint such an arbitarator, then the arbitrator so appointed shall appoint another arbitrator, and the two shall proceed as if one of them had been appointed by each of the parties hereto. The decision of such arbitrators or a majority of them shall be final and binding upon the parties hereto.

The American Association for the Advancement of Science hereby constitutes and appoints Forest Ray Moulton to be its attorney, for it and in its name, and as for its corporate act and deed, to acknowledge this indenture before any person having authority to take such acknowledgment, to the intent that the same may be duly recorded. This indenture is executed by the association pursuant to action taken by the executive committee of the council of said association at a meeting of said committee duly called and held on October 22, 1938.

IN WITNESS WHEREOF said grantors, James McKeen Cattell and Josephine Owen Cattell, have signed and sealed these presents and said association has caused these presents to be signed by its president and attested by its permanent secretary and has caused its corporate seal to be hereunto affixed the day and year first above written. Executed in duplicate.

### MINUTES OF EXECUTIVE COMMITTEE AND COUNCIL REFERRING TO EXECUTION OF INDENTURE

The executive committee at its regular meeting on October 22, 1938, took actions as expressed in the following items which were later approved in writing by all members who attended the meeting:

"A copy of the proposed indenture by which Dr. Cattell and Mrs. Josephine Owen Cattell propose to transfer to the association titles to SCIENCE and *The Scientific Monthly* was given by Dr. Cattell to each member of the Executive Committee."

"The members of the Executive Committee were requested to send their copies of the indenture to the Permanent Secretary with such changes in the wording of the indenture, without changing its meaning, as they might wish to suggest."

"The Permanent Secretary was requested to prepare revised copies of the indenture and to send one to each member of the Executive Committee."

"The Executive Committee approved and authorized the President and the Permanent Secretary to execute the indenture, subject to such changes in wording, without changing its meaning, as might be desirable."

On recommendation of the Executive Committee, the Council on December 30, 1938, adopted the following resolution:

"Resolved that the Council, having accepted [by action of the Executive Committee under authority of the By-Laws Art. IV., Sec. 1: "The Executive Committee shall have full power to act for the Council when the Council is not in session."] on October 22, 1938, the offer of J. McKeen Cattell and Josephine Owen Cattell to sell and transfer to the A. A. A. S. the journals SCIENCE and *The Scientific Monthly,* and having directed the Executive Committee to complete the details of the purchase and transfer, hereby approves and ratifies the action of the President and Permanent Secretary in executing on December 12, 1938, by direction of the Executive Committee, the contract on behalf of the A. A. A. S."

Thereupon the Council initiated and passed the following motion:

"The Council again expresses to Dr. Cattell and Mrs. Cattell its appreciation of the work they have carried on for many years in editing and publishing the journals, and for transferring them to the A. A. A. S. under most generous terms."

# MEMBERSHIP OF THE AMERICAN ASSOCIATION

By Dr. F. R. MOULTON
PERMANENT SECRETARY

SINCE the sections of the American Association for the Advancement of Science and its affiliated and associated societies cover rather comprehensively all the natural and social sciences, its record of membership is at least a rough measure of the progress of science. Since the association is truly national in scope, the geographical distribution of its membership measures approximately the distribution of interest in science in the United States.

For the purposes of this discussion it will be sufficient to present the membership of the association and the population of the United States by decades, except

for the interval from 1930 to 1940 in which the membership of the association is especially interesting because of economic conditions and the relatively small increase in population. The association was organized in 1848 with a membership of 461. The statistics will be presented in Table I for the years divisible by 10 because the U. S. Bureau of the Census gives the population of the country for these years.

TABLE I

MEMBERSHIP OF ASSOCIATION AND POPULATION OF UNITED STATES, 1850–1940

| Year | Membership | Change Per cent. | Population (millions) | Increase Per cent. |
|---|---|---|---|---|
| 1850 .... | 684 | | 23.2 | 35.9 |
| 1860 .... | 644 | −5.8 | 31.4 | 35.6 |
| 1870 .... | 536 | −16.8 | 39.8 | 26.6 |
| 1880 .... | 1,555 | 29.0 | 50.2 | 26.0 |
| 1890 .... | 1,944 | 12.5 | 62.9 | 25.5 |
| 1900 .... | 1,925 | −1.0 | 76.0 | 20.7 |
| 1910 .... | 8,021 | 41.6 | 92.0 | 21.0 |
| 1920 .... | 11,547 | 14.4 | 105.7 | 14.9 |
| 1930 .... | 19,059 | 16.5 | 122.8 | 16.1 |
| 1940 .... | 21,065 | 1.1 | 131.7 | 7.2 |

The decline in membership in the interval 1860–1870 may be ascribed to the Civil War; in fact, the association held no meetings in 1861–65, inclusive. There was a serious and prolonged depression in the decade 1890–1900. In 1900 SCIENCE became the official journal of the association. The period 1910–1930 was one of phenomenal increase in the applications of science in industry. The decade 1930–1940 (Table II) was one of depression and recession in industry and of slow increases in universities.

TABLE II

MEMBERSHIP DATA FOR 1930–1940

| Year | New members, reinstatements | Members died or resigned | Total members | Change Per cent. |
|---|---|---|---|---|
| 1930 ..... | 1,507 | 910 | 19,059 | 3.2 |
| 1931 ..... | 1,977 | 1,147 | 19,889 | 4.4 |
| 1932 ..... | 1,397 | 1,621 | 19,665 | −6.2 |
| 1933 ..... | 823 | 1,939 | 18,549 | −5.7 |
| 1934 ..... | 2,029 | 2,025 | 18,553 | 0.0 |
| 1935 ..... | 1,171 | 1,878 | 18,102 | −2.4 |
| 1936 ..... | 1,513 | 1,208 | 18,242 | 0.7 |
| 1937 ..... | 1,142 | 1,081 | 18,776 | 2.9 |
| 1938 ..... | 2,156 | 1,112 | 19,059 | 1.5 |
| 1939 ..... | 2,210 | 1,362 | 20,195 | 6.0 |
| 1940 ..... | 2,195 | 1,323 | 21,065 | 4.3 |
| Average .... | 1,647 | 1,419 | 19,196 | 0.8 |

New members of the association are obtained from direct applications for membership, from invitations extended to persons listed in directories of scientists and from nominations for membership, by existing members. The first source does not result in a large number of new members, the second is costly, the third is cheapest and the most effective. The total cost of circularizing for new members in the eleven years was $43,419; average per year, $3,947.

There have been marked changes in the geographical distribution of the membership of the association even during recent years. For brevity comparative statistics for the United States will be presented only for the years 1936 and 1940, an interval during which there has been a continuous increase in membership of the association. In order to give a somewhat longer base for comparisons of the number of members in foreign countries, statistics will be presented for 1934 and 1940.

TABLE III

MEMBERSHIP OF THE ASSOCIATION AND THE DIVISIONS

| | 1936 | 1940 | Increase |
|---|---|---|---|
| | | | Per cent. |
| Entire Association ..... | 18,242 | 21,065 | 15.5 |
| Pacific Division[1] ..... | 1,934 | 2,075 | 7.3 |
| Southwestern Division ..... | 338 | 377 | 11.5 |

[1] The Pacific Division (organized in 1915) includes members of the association resident in Alaska, British Columbia, Washington, Oregon, California, Idaho, Utah, Nevada and Hawaii.

[2] The Southwestern Division (organized in 1920) includes members of the association resident in Arizona, New Mexico, Colorado, Sonora and Chihuahua (Mexico), and Texas west of the 100th meridian. The territory between the Pecos River and 100th meridian was added in 1937, the division acquiring 28 members by the addition. Without this addition the increase in membership in the interval 1936–1940 is 3.3 per cent.

The variations in the increase in membership of the association from one region to another are in part due to variations in rates of increase of the entire populations. To make possible a rough allowance for this factor the changes of population are included for the decade 1930–1940 (census years) in Table IV.

TABLE IV

GEOGRAPHICAL DISTRIBUTION OF MEMBERS

| | Members[1] | Increase[2] | Population change[3] | Members per 10,000 population |
|---|---|---|---|---|
| | | Per cent. | Per cent. | |
| **New England States** | | | | |
| Maine ..... | 92 | 9.5 | 6.2 | 10.9 |
| New Hampshire .. | 97 | 12.8 | 5.6 | 19.7 |
| Vermont ..... | 74 | 60.9 | −0.1 | 20.6 |
| Massachusetts .... | 1,155 | 8.1 | 1.6 | 26.7 |
| Rhode Island .... | 108 | 1.0 | 3.8 | 15.1 |
| Connecticut ..... | 445 | 16.2 | 6.4 | 26.0 |
| | 1,971 | 11.1 | 3.3 | 23.4 |
| **Middle Atlantic States** | | | | |
| New York ..... | 3,430 | 7.4 | 7.1 | 25.4 |
| New Jersey ..... | 782 | 19.0 | 2.9 | 18.8 |
| Pennsylvania ..... | 1,416 | 10.0 | 2.8 | 14.3 |
| | 5,628 | 9.5 | 4.8 | 20.4 |
| **South Atlantic States** | | | | |
| Delaware ..... | 85 | 18.1 | 11.8 | 31.9 |
| Maryland ..... | 550 | 23.0 | 11.6 | 30.2 |
| Virginia ..... | 382 | 48.1 | 10.6 | 14.3 |
| West Virginia .... | 132 | 12.0 | 10.0 | 6.9 |
| North Carolina ... | 259 | 30.1 | 12.7 | 7.2 |
| South Carolina ... | 91 | 28.3 | 9.3 | 4.8 |
| Georgia ..... | 158 | 38.6 | 7.4 | 5.1 |
| Florida ..... | 193 | 40.9 | 29.2 | 10.2 |
| | 1,850 | 31.4 | 12.9 | 10.4 |
| **East North Central States** | | | | |
| Ohio ..... | 1,101 | 25.0 | 3.9 | 15.9 |
| Indiana ..... | 380 | 26.3 | 5.8 | 11.1 |
| Illinois ..... | 1,392 | 22.1 | 3.5 | 17.6 |
| Michigan ..... | 649 | 25.5 | 8.5 | 12.3 |
| Wisconsin ..... | 401 | 21.9 | 6.8 | 12.8 |
| | 3,923 | 23.8 | 5.3 | 14.7 |

| | | | | |
|---|---|---|---|---|
| **West North Central States** | | | | |
| Minnesota | 443 | 17.8 | 8.9 | 15.9 |
| Iowa | 319 | 11.9 | 2.7 | 12.6 |
| Missouri | 447 | 0.7 | 4.3 | 11.8 |
| North Dakota | 43 | −4.4 | −5.7 | 6.7 |
| South Dakota | 40 | 17.6 | −7.2 | 6.2 |
| Nebraska | 170 | 23.2 | −4.5 | 12.9 |
| Kansas | 191 | 11.7 | −4.3 | 10.6 |
| | 1,653 | 10.7 | 1.7 | 12.2 |
| **East South Central States** | | | | |
| Kentucky | 168 | 20.9 | 8.8 | 5.9 |
| Tennessee | 177 | 12.0 | 11.4 | 6.1 |
| Alabama | 124 | 39.3 | 7.1 | 4.4 |
| Mississippi | 52 | 18.2 | 8.7 | 2.4 |
| | 521 | 21.2 | 10.9 | 4.8 |
| **West South Central States** | | | | |
| Arkansas | 56 | 43.6 | 5.1 | 2.9 |
| Louisiana | 179 | 12.6 | 12.5 | 7.6 |
| Oklahoma | 166 | 31.7 | −2.5 | 7.1 |
| Texas | 485 | 22.8 | 10.1 | 7.6 |
| | 886 | 30.5 | 7.3 | 6.8 |
| **Mountain States** | | | | |
| Montana | 61 | 1.6 | 4.1 | 10.8 |
| Idaho | 33 | −19.5 | 17.9 | 6.3 |
| Wyoming | 33 | 17.9 | 11.2 | 13.2 |
| Colorado | 186 | −1.1 | 8.4 | 16.6 |
| New Mexico | 83 | 23.9 | 25.6 | 15.6 |
| Arizona | 98 | 5.4 | 14.6 | 19.6 |
| Utah | 93 | 29.1 | 8.4 | 16.9 |
| Nevada | 37 | 2.8 | 21.1 | 33.6 |
| | 624 | 6.6 | 11.2 | 15.0 |
| **Pacific States** | | | | |
| Washington | 218 | 20.4 | 11.1 | 12.5 |
| Oregon | 153 | 19.5 | 14.2 | 14.0 |
| California | 1,601 | 11.2 | 21.7 | 23.2 |
| | 1,972 | 12.8 | 18.8 | 20.3 |

OTHER AREAS

| | *June 1, 1934* | *July 1, 1940* | *Increase* |
|---|---|---|---|
| **Other U. S. Areas** | | | *Per cent.* |
| District of Columbia | 842 | 938 | 11.4 |
| Alaska | 11 | 15 | 36.4 |
| Hawaii | 89 | 94 | 5.6 |
| Total | 942 | 1,047 | 11.1 |
| **U. S. Possessions** | | | |
| Puerto Rico | 35 | 61 | 74.3 |
| Philippines | 56 | 61 | 8.9 |
| Canal Zone | 13 | 13 | 0.0 |
| Total | 104 | 135 | 29.8 |
| **Foreign Countries and Areas**[4] | | | |
| Canada | 338 | 441 | 30.5 |
| Mexico | 29 | 32 | 10.3 |
| Central and South America | 66 | 123 | 86.4 |
| European countries | 157 | 127 | −19.1 |
| African countries | 22 | 24 | 9.1 |
| Asiatic countries | 118 | 124 | 5.1 |
| Australasia | 12 | 15 | 25.0 |
| Total | 742 | 886 | 19.4 |

[1] Statistics for members are for September 30, 1940, the close of the fiscal year.

[2] Increase in membership is from September, 30, 1936, to September 30, 1940.

[3] The population changes are for the decade 1930–1940.

[4] On July 1, 1940, there were members of the association resident in 75 foreign countries. They are decreasing rapidly in Europe as a consequence of the war.

# OBITUARY

## SIR JOSEPH JOHN THOMSON

IT is characteristic of the progress of science that periodically stages are reached at which possibilities of new discoveries seem to have come to an end. The wonders of the days which have passed have become moulded into a theory in terms of which the understanding of man is content. And the theory, having in its new-born state contributed to progress by suggesting further possibilities, finally reaches a point at which it has no more to say. In its old age it sits down, claims that all is finished, that there will be nothing new, and spends its declining years in grumbling about the impossibility of anything which, in the mind of some enthusiast, seems as though it might be possible. And then some new upstart does find new phenomena uncontemplated by the theory. A minor revolution in thought has to be created and while the new epoch is being stabilized many new things are born. Freed from restraint, discovery runs ahead of the warnings of the theories as to what can and can not be discovered. Science has a new lease of life, and a new generation of its workers is born.

It was in such a period of transition that J. J. Thomson came upon the scene. He came thoroughly trained in the old school of mathematical analysis, the school of Newton and of Maxwell and of Kelvin and of Rayleigh, but he came to an orchard in which all the good fruit seemed to have been picked. After a few early flutters in which his genius enabled him to find a little more fruit even among the trees which had already yielded so much and in which he wrote on "vortex rings" and on "application of dynamics to physics and chemistry," he became attracted to that curious realm of phenomena so dishearteningly complex, and without meaning to the school of thought of the day, phenomena having to do with the discharge of electricity in gases. His earlier work along the conventional lines had already brought him recognition in the form of election to the Cavendish professorship of physics in the University of Cambridge, so that at the age of 28 years he was able to start out upon that new field which was to bring immortality to his name and to give birth to a new school of physics and of physicists destined to carry science through a greater revolution of thought and phenomena in the space of half a century than had been achieved during the whole previous history of the human race.

At the time when Thomson commenced his work, science had acquired almost an inferiority complex in expression to its utterances. Dynamics, so dignified by the illustrious Newton and his followers, was always admitted with respect in all the halls of learning provided that it did not talk about anything too concrete. The more generalized the coordinates the happier the mathematical physicist, who was thereby

relieved from the necessity of saying what he was talking about and was able to feel something of the exhilaration of a pure mathematician who, as Sylvester, one of its great exponents, once remarked, was never so happy as when he did not know what he was talking about.

In this age one was permitted to speak of a current of electricity, but woe betide the young man who thereby implied that he thought anything was moving along the wire carrying the current. The guilt of such a thought would almost threaten in his dreams, a nightmare in which the white whiskers of Kelvin, and even the less white whiskers of Maxwell trembled in pious condemnation. Even molecules and atoms were spoken of in whispers, and as for things smaller than atoms, even the great Kelvin complained that the very word "atom" implied that the entity was indivisible. The concept of an ether had been admitted with a mixture of fear and joy; fear because it lay in the realm of the intangibles like the atoms and molecules, but joy in that the mathematical physicist promised that it would behave according to all the respectable canons of dynamics. Much time did they spend in trying to make the newcomer live up to his promises. The desire for a substantial ether and a conventional one is illustrated by such remarks as that of the eminent contemporary of J. J. Thomson, Arthur Schuster, who, as late as 1904, writes: "The study of physics must be based on a knowledge of mechanics, and the problem of light will only be solved when we have discovered the mechanical properties of the ether." Writing, in another place, of Maxwell's equation, he remarks: "The fact that this evasive school of philosophy has received some countenance from the writings of Heinrich Hertz renders it all the more necessary that it should be treated seriously and resisted strenuously."

At Cambridge, Thomson created a "school" of research which was in a sense unique in the annals of the time. It was a school of men and ideas rather than of buildings and equipment. It was a school of primitive pumps and sealing wax, of makeshift appliances in which the maximum of ingenuity was called upon to supplement the resources. It was a school strange to the experimental conventions of the times; for physics, having, as it thought, sensed the ultimate end of its possibiilties, was engaged in pursuing the last decimal in thermal constants and the like, with the use of more and more precise measuring apparatus. Then this new school faced the doubtful eye of the traditional dons of the university, who had many misgivings as to experimental research even with dignified apparatus, regarding it as representative of a kind of glorified plumbing. They were moved almost to consternation when such work laid claims to academic distinction and when, moreover, the whole business was being conducted by a young man less than 30 years of age in whom, according to the traditions of the times, the fundamentals of academic solemnity could hardly be regarded as having been formed.

However, the "school" of research thrived, a host of new phenomena burst from their prisons amid the shouts of others waiting to be released. The stimulus of the times crystallized to a maximum the genius of those who were the participants of the new hunt for truth. Rutherfords were born, the children of the new school spread to all parts of the world, and it became almost impossible to obtain any sort of a worthwhile job in physics in any part of the British Empire unless one had the seal of the Cavendish Laboratory upon him.

The great outpouring of new phenomena following the first discoveries in the field, the youth of the great leader himself, and the continuity in the richness of discovery since, have hardly allowed breath to take note of the passage of time, and it is hard to realize that J. J. Thomson was 83 years of age when he died. He is still symbolized in the thoughts of many as "a young man."

Thomson himself was a unique mixture of the old school from which he was born and the new school which he had created. Trained in the rigid domains of classical mathematical physics, he possessed all the powers of that heavy artillery when necessary. Moreover, his early inoculation with the spirit of the classical age kept strong in him the desire to understand phenomena in terms of mechanical pictures. Even the Bohr-Sommerfeld theory did not appeal to him very strongly at its birth, and one has the feeling that when the new wave mechanics developed, he felt a certain comfort in his age that it relieved him of the necessity of meddling with it. In spite of this conservatism, he himself was extremely bold in speculation and it adds only to the weight of his genius that those of his accomplishments which were successful were so great in their success as to cast into shadow many things and ideas which, taken by themselves, could by no means be regarded as successes. Thomson was a radical in physics, but like many radicals in science, he became extremely conservative in his own radicalism.

As an experimenter he was apt to rely for manipulation upon his assistants and, in harmony with the whole "school" of his creation, he was interested more in results than in the methods of obtaining them. He was a man of broad interests and his "Recollections and Reflections" show many sidelights upon his character, and contain much that could well be digested with profit by those who become too narrow in their views of academic training or in the importance of stereotyped routine. In one place he writes:

There is no better way of getting a good grasp of your subject, or one more likely to start more ideas for research, than teaching it or lecturing about it, especially if your hearers know very little about it, and it is all to the good if they are rather stupid. You have then to keep looking at your subject from different angles until you find the one which gives the simplest outline, and this may give you new views about it and lead to further investigations. I believe, too, that new ideas come more freely if the mind does not dwell too long on one subject without interruption, but when the thread of one's thoughts is broken from time to time. It is, I think, a general experience that new ideas about a subject generally come when one is not thinking about it at the time, though one must have thought about it a good deal before.

J. J. Thomson was born at Cheetham Hill, near Manchester, England, on December 18, 1856. He attended Owen's College, Manchester, in the 70's, and entered Trinity College, Cambridge University, in 1876. With Kelvin and Clerk Maxwell he formed one of an illustrious trio, none of whom succeeded in being Senior Wrangler. He was Second Wrangler and Second Smith's prize man in 1880, and he was elected as a fellow of Trinity College in the same year. In 1883 he was made lecturer at the college. In 1884 he became a fellow of the Royal Society, of which he was president from 1916 to 1920. From 1884–1918 he was Cavendish professor of experimental physics at Cambridge University, from which position he retired to become master of Trinity College. Naturally he was the recipient of numerous honors and distinctions, the author of countless papers and of several books, the most famous of which is his "Conduction of Electricity through Gases."

When a man dies one thinks of the spirit as vanishing and only of the body as remaining; but in the case of J. J. Thomson there is much of the reverse in the picture, for the spirit of the great leader is the thing which, born to science half a century ago when he founded his new school, lives still in his students and in their students, a spirit enthroned for all time in the empires of natural philosophy.

W. F. G. SWANN

BARTOL RESEARCH FOUNDATION
OF THE FRANKLIN INSTITUTE,
SWARTHMORE, PA.

# SCIENTIFIC EVENTS

## SCIENTIFIC DEVELOPMENTS IN THE U.S.S.R.

*Nature* gives the following information concerning the new botanical gardens in Armenia and the construction of a cyclotron in Moscow.

The construction of a powerful cyclotron, capable of producing 50 million electron volt deuterons, will be commenced in Moscow early in 1941, according to a decision of the Academy of Sciences of the U.S.S.R., based on a report submitted by the Physical Institute of the Academy. A magnet, the core of which weighs about 1,000 tons and solenoid of 18 tons, is to be installed. A special building to house the cyclotron will be erected in the grounds of the new home of the Physical Institute of the Academy, being built on the Bolshaya Kaluzhskaya Ulitsa in Moscow. The old apparatus in the Soviet Union, which is in the Radium Institute of Leningrad, is capable of giving an energy of 4 million electron volts to particles; another, nearing completion at the Physico-Technical Institute, also in Leningrad, will be capable of imparting an energy of 10–12 million electron volts.

New botanical gardens, attached to the Armenian Branch of the Academy of Sciences of the U.S.S.R., were recently opened in Erivan, capital of the Soviet republic of Armenia. The gardens, which have some three thousand species of plants, have grown up during the course of five years on the dry, stony, desert soil between the settlements of Avan and Kanaker, near Erivan, which has been reclaimed. One of the most interesting departments of the gardens is the section devoted to the plants of Armenia. Ultimately, some 2,600 specimens of the flora of this republic will be collected there; the section already has 350 specimens. In the center of this section has been built a pond, resembling the high mountain lake of Sevan. In the pond have been planted specimens of water plants of Armenia. In the southern part of the gardens the Geographical Department is concentrated. More than half the area of the gardens is occupied by arboreal plants. The flower gardens are exceptionally rich; in the Avenue of Roses and Fountains more than a hundred varieties of roses have been planted.

## THE DIVISIONAL PROGRAMS FOR THE ST. LOUIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

ACCORDING to the *News Edition* of the American Chemical Society, all divisions except the Division of Fertilizer Chemistry have programs planned for the St. Louis meeting, which will be held from April 7 to 11.

The Division of Agricultural and Food Chemistry is planning two symposia, one on "Fortification of Foods with Minerals and Vitamins" and the other on "Fats." The division plans to participate in the vitamin program

being arranged by the Division of Biological Chemistry. Time will also be available for general papers on agricultural and food subjects.

The new Division of Analytical and Micro Chemistry is planning six sessions for presentation of papers within the field of the division.

The Division of Biological Chemistry is again arranging its usual program of vitamin papers. It will also hold sessions for discussion of miscellaneous biochemical subjects.

The Division of Cellulose Chemistry will meet for two sessions devoted to general papers.

The Division of Chemical Education is again organizing a student program. In addition, the customary student breakfast will be held. The division will sponsor a symposium on "The Last Two Years of College Chemistry." It also plans sessions for miscellaneous papers within its field.

The Division of Colloid Chemistry will meet for two sessions of miscellaneous papers.

The Division of Gas and Fuel Chemistry will hold three sessions for the presentation of general papers and a symposium on "Smokeless Fuels and Air-Pollution Abatement."

The Division of the History of Chemistry plans two sessions of miscellaneous papers. Attention is directed to the fact that the division does not confine its interests to biography, but solicits papers on the historical aspects of all branches of chemistry. Non-members of the division are invited to contribute papers or exhibit historical books, manuscripts or apparatus.

The Division of Industrial and Engineering Chemistry is sponsoring a symposium on "New Engineering Technique." A program of general papers also will be arranged.

The Division of Medicinal Chemistry has arranged a symposium on "Some Current Projects in Medicinal Chemistry." Two sessions will be available for the prsentation of miscellaneous papers on medicinal chemistry.

The Division of Organic Chemistry will offer six sessions of papers.

The Division of Paint, Varnish and Plastics Chemistry is arranging a symposium on "Phenol-Formaldehyde Resins and Plastics." Sessions will be available for miscellaneous papers within the field of the division.

The Division of Petroleum Chemistry will sponsor a symposium on "Analytical Methods Used in the Petroleum Industry." Time will also be available for other papers on petroleum chemistry. This meeting will mark the twentieth anniversary of the founding of this division. The event will be appropriately celebrated at a special dinner Tuesday evening, April 8.

The Division of Physical and Inorganic Chemistry has organized symposia on "The Nomenclature of Inorganic Chemistry" and on "The Thermodynamics of Electrolytic Dissociation." Time will also be available for other papers within the field of the division. The division will meet for dinner on Monday evening, April 7. Authors are requested to note that papers on analytical chemistry, heretofore presented before this division, should now be submitted to the newly formed Division of Analytical and Micro Chemistry.

The Division of Rubber Chemistry will meet on Thursday and Friday for a program of papers on general subjects pertaining to rubber chemistry and technology and for a symposium on "New Developments in the Processing of Rubber."

The Division of Sugar Chemistry and Technology is scheduling papers describing contemporary work in the monosaccharide field, in commemoration of the appearance of Fischer's first papers on the sugars. In addition, time will be available for the presentation of miscellaneous papers within the field of the division.

The Division of Water, Sewage and Sanitation Chemistry will have two general sessions.

## SCIENTIFIC MEETINGS

THE fifth annual meeting of the Association of Southeastern Biologists will be held in Auburn, Ala., on April 11 and 12 at the Alabama Polytechnic Institute, under the presidency of Professor Robert C. Rhodes, of Emory University. Accommodations are being provided in the dormitories; reservations should be made through Professor Reed O. Christenson, of Auburn. One portion of the program will consist of a symposium on "Biological Problems Affecting the Welfare of the Southeastern States." The leaders will be: Dean M. J. Funchess, of the College of Agriculture and Experiment Station, Alabama Polytechnic Institute; Dr. Charles N. Leach, International Health Division of the Rockefeller Foundation, and the Alabama State Board of Health; Dr. Benjamin Schwartz, U. S. Department of Agriculture, and Dr. A. E. Hopkins, U. S. Bureau of Fisheries. Abstracts of papers to be presented at the meeting must be in the hands of the secretary, Dr. Donald C. Boughton, Regional Laboratory, Auburn, not later than March 15.

THE thirty-fourth annual meeting of the American Home Economics Association will be held in Chicago, from June 22 to 26, with the Stevens Hotel as headquarters. This organization, founded in 1908, now has over 15,000 members scattered through fifty affiliated home economics associations in the United States, the District of Columbia and Puerto Rico, besides about 2,300 affiliated home economics student clubs in colleges and high schools. Dr. Gladys Branegan, dean of the division of household and industrial arts at Montana State College, is president of the association. Miss Frances L. Swain, director of household arts in the Chicago public schools, is chairman of the committee on local arrangements. The program is in charge of a committee whose chairman is Miss Lita Bane, head of the department of home economics at the University of Illinois. The exhibits will, as usual, include those by commercial concerns and by govern-

ment and professional groups with aims akin to those of home economics. Exhibits showing the work of departments, divisions and committees of the association will also be shown.

THE University of Chicago and the University of Wisconsin have organized a joint symposium on "The Respiratory Enzymes and the Biological Action of the Vitamins" to be held both at Madison and Chicago next September. The University of Wisconsin sessions, which will be devoted to the respiratory enzymes, are planned for September 11 to 13, and the meetings dealing with the vitamins will take place at Chicago on September 15 and 16 and 17. The program is an attempt to coordinate the biological action of the vitamins and the respiratory enzymes. Details may be had from Professor C. A. Elvehjem, of the University of Wisconsin, or from Professor T. R. Hogness, of the University of Chicago. The symposium is supported by the Wisconsin Alumni Foundation, for the University of Wisconsin, and by the Abbott Laboratories, for the University of Chicago. The Chicago sessions will form a part of the Semi-Centennial Celebration of the university.

## THE AMERICAN ASSOCIATION OF MINING AND METALLURGICAL ENGINEERS

THE program of the one hundred and fifty-fourth meeting of the American Institute of Mining and Metallurgical Engineers, held in New York City from February 17 to 24, included sixty technical sessions, at which three hundred scientific papers were presented.

At the annual banquet at the Hotel Commodore on the evening of February 17 John Robert Suman, vice-president of the Humble Oil and Refining Company, Houston, Texas, was installed as president. He succeeds Herbert George Moulton, consulting engineer. Vice-presidents installed were Dr. Paul D. Merica and LeRoy Salsich.

George C. Bateman, controller of metals, Canadian Ministry of Munitions and Supply, and president of the Canadian Institute of Mining and Metallurgy, addressed the general session on February 17 on "Canadian Control of Metals in the War for Democracy," and Alfred V. de Forest, professor of mechanical engineering of the Massachusetts Institute of Technology, gave on the following day the eighteenth Howe Memorial lecture.

At the dinner of the division of the Institute of Metals on February 20 Laurence A. Hawkins, executive engineer of the research laboratories of the General Electric Company, spoke on "Research and Progress." Eugene Holman, director of the Standard Oil Company of New Jersey, spoke on the same evening at the Petroleum Division dinner at the Biltmore Hotel on "Petroleum Transport Problems."

The twentieth annual lecture of the Institute of Metals Division was delivered on Wednesday afternoon by Professor George Sachs, of the department of metallurgy, Case School of Applied Science. His subject was "Some Fundamentals of the Flow and Rupture of Metals."

There was a large exhibit of heating, ventilating, air conditioning, plumbing and associated building equipment.

## PRESENTATION OF A PORTRAIT OF PROFESSOR COHEN

A PORTRAIT of Professor Abraham Cohen, who has recently retired from a professorship of mathematics in the Johns Hopkins University, was presented to the university at the Commemoration Day Exercises on February 22. In presenting the portrait to the trustees, Professor F. D. Murnaghan made the following comments:

I have the high honor of presenting to you to-day a portrait of Professor Abraham Cohen. In making this presentation, I act for a large group of his colleagues, friends and former students, who, as soon as his impending retirement was announced, expressed their desire to have his portrait painted and presented to the university as a token of their esteem and in recognition of his distinguished service. Professor Cohen was born in Baltimore in 1870 and entered the Johns Hopkins University in 1888. He took his A.B. in 1891 and his Ph.D. in 1894, specializing in mathematics. After a year of study in Europe, he returned as instructor in mathematics in 1895, and since that date his connection with Hopkins has been unbroken. I do not deem it proper for me here to call attention to his distinction as a mathematician, nor to record the successful text-books he has published and which are used not only in this country but in Europe. Nor shall I dwell on the fact that under his editorship the *American Journal of Mathematics* held the high distinction of being one of the leading mathematical journals in the world. Rather I should like to point out two things:

First the universal feeling of respect among his students for their teacher as a gentleman and of liking for him as a man whose patience with their weaknesses was inexhaustible. After a lapse of nearly half a century, his former students recall the deep impression left on them by this humanity of their professor. In the second place I point to the somewhat unusual and intimate connection of this occasion with our city of Baltimore. Here we have one of her citizens who attended her public schools, then her famous university, and then devoted his entire life to an unselfish, unstinted and distinguished service to his university and to his city. I like to feel that here at least we have an example of a prophet who has been recognized in his own country.

I can find, Mr. President, no better words to close my presentation than the following: In this portrait, so ably painted by the artist, Mr. Haupt, you have for future generations the presentment of a man whose life has been

devoted to the noble aim of upholding "the golden heresy of truth."

## RECENT DEATHS

DR. CHARLES WALLIS EDMUNDS, professor of materia medica and therapeutics at the School of Medicine of the University of Michigan, died on March 1 at the age of sixty-eight years.

PROFESSOR ALBERT ROBERT ACHESON, head of the department of mechanical engineering in the College of Applied Science of Syracuse University, died on February 25. He was fifty-nine years old.

DR. ARTHUR ERICH HAAS, professor of physics at Notre Dame University, died on February 20 at the age of fifty-seven years.

DR. HENRY SELBY HELE-SHAW, emeritus professor of engineering at the University of Liverpool, died on February 3 at the age of eighty-six years. He was the first professor of engineering to hold the Harrison chair at University College, Liverpool. In 1905 he was appointed organizer of technical education in the Transvaal.

# SCIENTIFIC NOTES AND NEWS

THE Council of the Geological Society, London, has awarded the Wollaston Medal to Dr. Arthur L. Day, who retired in 1936 as director of the Geophysical Laboratory of the Carnegie Institution of Washington.

PRESIDENT RAY LYMAN WILBUR, who observed his twenty-fifth anniversary as president of Stanford University on January 19, will retire at the close of the present academic year. Dr. Wilbur became president of Stanford in 1916, having previously been professor of medicine and dean of the Medical School.

DR. E. A. BIRGE, formerly president of the University of Wisconsin, who is now 89 years old, has received a specially printed copy of a joint resolution extending to him the congratulations of the Wisconsin Legislature. The resolution was adopted unanimously by both senate and assembly. It reads: "WHEREAS, the University of Wisconsin's President Emeritus E. A. Birge was honored last fall by national scientists and Wisconsin friends on the occasion of his eighty-ninth birthday; and, WHEREAS, this grand old man, known to so many as 'Dean Birge,' became associated with the University of Wisconsin in 1875 as instructor of natural history, and has an outstanding record of public service through these sixty-six years, probably equaled by no other Wisconsin citizen; now, therefore, be it *Resolved* by the senate, the assembly concurring, that the Wisconsin Legislature pause in its deliberations to extend sincere congratulations and felicitations to Dean Birge for his long continued, distinguished services to the university and to the State of Wisconsin."

ON the occasion of the eightieth birthday on February 15 of Dr. Alfred North Whitehead, professor of philosophy emeritus of Harvard University, a celebration, at which he was the guest of honor, was held at the Faculty Club by friends and associates. A bound book containing a birthday greeting, signed by five hundred of his colleagues and former pupils reads: "We who sign this greeting are your friends and students. No one can be your student without being your friend, or be your friend without learning from you unforgettable lessons of wisdom and kindness. During these dark days we think constantly of you, and derive courage from your high-mindedness and serenity. On this, your birthday, we join in sending to you and to Mrs. Whitehead the assurance of our devoted love."

THE retirement from active service is announced of Dr. N. H. Williams, since 1918 professor of physics at the University of Michigan. The retirement of Dr. H. M. Randall, also professor of physics and chairman of the department, has already been reported in SCIENCE.

DR. PAUL C. BUCY, assistant professor of neurosurgery at the University of Chicago, has been appointed associate professor of neurology and neurological surgery at the University of Illinois College of Medicine, Chicago. Dr. Bucy succeeded Dr. Percival Bailey as chief neurological surgeon at the University of Chicago when Dr. Bailey joined the staff of the University of Illinois in September, 1939. Both are now associated with Dr. Eric Oldberg, professor and head of the department of neurology and neurological surgery at the new Neuropsychiatric Institute which has just been completed for the University of Illinois at Chicago.

DR. R. A. GOODWIN, formerly of the North Dakota Agricultural College, has joined the department of physics of the Fort Hays Kansas State College.

JOHN DOUGLAS RYDER, of the Research and Development Laboratory of the Bailey Meter Company, Cleveland, Ohio, has been appointed assistant professor of electrical engineering at the Iowa State College.

DR. LUDWIG HEKTOEN, executive director of the National Advisory Cancer Council, was elected honorary

chairman of the board of governors of the Institute of Medicine of Chicago at its recent annual meeting. Dr. Hektoen, who has been chairman of the board, was succeeded by Dr. William M. Petersen.

DR. CHARLES FRANKLIN KETTERING, president of the General Motors Research Corporation, was recently elected a member for a seven-year term of the Board of Trustees of the Ohio State University.

DR. SHIRLEY W. WYNNE, formerly health commissioner of New York, was elected on February 4 president of the Associated Health Foundation, a nonprofit medical service corporation. This foundation is conducted under the sanction of the New York State Department of Insurance and the Board of Social Welfare. It offers virtually complete medical, surgical, laboratory and x-ray care for individuals making less than $3,000 a year, where there are families to support, and $1,800 in the case of persons with no dependents.

DR. H. R. CRANE and Dr. James L. Lawson, of the department of physics of the University of Michigan, have leave of absence to serve on the National Defense Research Committee.

PROFESSOR HERBERT M. EVANS, director of the Institute of Experimental Biology at the University of California at Berkeley, has left for a goodwill tour of Latin America on behalf of the State Department. Dr. Evans, who will visit cultural and scientific centers, traveling by airplane, is an envoy of Secretary of State Cordell Hull and the university. The tour is a part of the program for cementing Pan American relations through cultural exchange. It is being financed principally by the government of Uruguay and the Guggenheim Foundation. The main purpose of the trip is the occasion of the Second Pan American Congress of Endocrinology, to be held at Montevideo from March 5 to 8. Dr. Evans will give one of the main addresses at the congress, and plans to speak at ten Latin American universities, including universities in Brazil, Argentina, Chile, Peru and Mexico.

DR. LANCELOT HOGBEN, Regius professor of natural history at the University of Aberdeen, author of "Mathematics for the Millions," who was last year guest professor of genetics at the University of Wisconsin, has sailed for England.

THE Geological Society of America has awarded a research grant to Professor John T. Lonsdale, head of the department of geology at the Iowa State College. This will enable Dr. Lonsdale to study the Chisos Mountains of Texas during the summer. These mountains have been the scene of intense volcanic activity. The project is included among the research studies of the Industrial Science Research Institute of the college.

DR. MEYER M. HARRIS, research associate of the New York State Psychiatric Institute, has received a grant-in-aid from the Committee on Scientific Research of the American Medical Association in support of studies on the effect of food factors in neuromuscular diseases.

DR. PETER K. OLITSKY, member of the Rockefeller Institute for Medical Research, New York City, addressed the University of Cincinnati Chapter of Sigma Xi (through the courtesy of the B. K. Rachford Lectureship Fund) on February 12, on "Hans Zinsser and His Studies on Typhus Fever."

DR. FARRINGTON DANIELS, professor of physical chemistry at the University of Wisconsin, will deliver the first John Howard Appleton Lecture for the year 1940–41 in the Metcalf Auditorium of Brown University on the evening of March 11. His subject will be "Photosynthesis."

PROFESSOR G. H. PARKER, of Harvard University, lectured in New Orleans on February 19 before the Physiological Department of Tulane Medical School on "The Control of the Human Body by Nerves and by Hormones." On February 20 he lectured at the Louisiana State University on "Recent Views on the Action of the Nervous System as illustrated by the Color Changes in Animals" and on the following day he conducted a seminar on the same subject.

REGINALD PATRICK LINSTEAD, professor of organic chemistry at Harvard University, formerly of the Imperial College of Science and Technology, London, will give from March 7 to 15 the seventh Connecticut Valley lecture series. He will speak on "The Pattern of Large Organic Molecules" at Mount Holyoke College on March 7; at Amherst College on March 8; at Smith College on March 14, and at the Massachusetts State College on March 15.

THE one hundred and twentieth anniversary of the founding of the Philadelphia College of Pharmacy and Science was observed on Monday, February 24. The principal address of the morning exercises was delivered by Henry B. Allen, director of the Franklin Institute of the Commonwealth of Pennsylvania.

THE first of a series of lectures designed to preserve the memory of Professor Henry Edward Armstrong, chief chemical adviser to the British Ministry of Home Security and past president of the Society of Chemical Industry, who has been described in recent years as "The father of British Chemistry," was given on February 3 by his son, Dr. Edward Frankland Armstrong, at the rooms of the Chemical Society, London. Professor Armstrong died in 1937 at the age of eighty-nine years.

THE twelfth annual meeting of the American Asso-

ciation of Physical Anthropologists will be held on April 7 and 8 immediately preceding the meetings of the American Association of Anatomists on April 9, 10 and 11. The meeting is held in conjunction with the fiftieth anniversary celebration of the University of Chicago. Symposia are being arranged on several topics, including anthropometric techniques and the physical anthropology of the American Indian. The annual dinner will be held on Monday evening, April 7. Following this, Dr. Aleš Hrdlička will give an address on "The Physical Characteristics of Alaskan and Siberian Peoples."

THE first annual meeting of the Collaborators of the U. S. Plant, Soil and Nutrition Laboratory was held at Ithaca, New York, on January 23 and 24. Collaborators were present from all parts of the country. The meeting was devoted to a detailed consideration of the objectives and procedures of the laboratory program. This program is broadly concerned with the plant and soil factors involved in the production of a food supply of a higher nutritional quality, and thus with the improvement of the nutrition and health of man and animals.

BY the will of Emil Bommer, a Brooklyn manufacturer, Dartmouth College receives $500,000 and an interest in his residual estate.

A DESERT MUSEUM at Palm Springs, Calif., was opened on February 19. It occupies a room in the Library Building and is concerned with the natural history of the desert areas, including anthropology. The director of the museum is Lloyd Mason Smith.

*The New York Times* reports that a decree vesting control over scientific expeditions engaged in research in Colombia in a group composed of representatives of the Foreign, Finance, Education, Commerce and War Ministries has been signed by President Eduardo Santos. This group will report to the government on all applications after study of the object of the expedition and the competence of members. The government will censor all photographs and written reports before they are permitted to leave the country.

THE London *Times* states that scientific apparatus used by Dalton, the chemist and mathematician who propounded the atomic theory of chemical action, are among treasures believed to have been destroyed in a recent raid in Manchester. The apparatus was one of the show pieces at the home of the Literary and Philosophical Society, which was wrecked.

MOUNT ZION HOSPITAL, San Francisco, opened on January 31 a Cardio-Vascular Research Laboratory under the direction of Dr. Meyer Friedman. The laboratory will be devoted solely to the investigation of diseases affecting the heart, the kidney and the peripheral blood vessels.

THE *News Edition* of the American Chemical Society gives an account of plans for the new analytical control laboratories to be built at the headquarters plant of Merck and Company at Rahway, N. J., the construction of which will require from six to eight months. The control division which will occupy the new building is responsible for testing all raw materials, ingredients, products and packages for the company, which turns out some 3,000 separate items in 13,000,000 containers per year. The main operating laboratory will be on the top floor where artificial lighting will be supplemented by skylight illumination of the saw-tooth type. Throughout the building, interior lighting will be achieved with fluorescent tubes. There are special laboratories on the second floor. Filtered fresh air will be forced into the building and distributed through a system of ventilating ducts, permitting change of air every five minutes. Reenforced concrete construction will be employed and the exterior walls will be of brick. Inside the building, floors will be of mastic tile, laid on concrete. The main floor area will be 72 x 140 feet.

DR. GEORGE GRANT MACCURDY, director of the American School of Prehistoric Research, writes to SCIENCE that he recently received notice of the discovery of a cavern near Montignac (Dordogne), containing numerous rare examples of paleolithic mural art. These can be described in the words of the prehistorian, Abbé Henri Breuil: "They are drawings, engravings and paintings in an extraordinary state of preservation, perhaps the most important series yet brought to light. We have found up to the present over 120 examples. Splendid artists have decorated these cavern walls with bison hunters and their composition is akin to that of the engravings at Les Eyzies, not far away. There are various ochre colors, the like of which are only found in the cavern of Altamira, Spain, and a sense of movement thus far unequaled anywhere. The paintings are at least 30,000, and perhaps 40,000 years old."

VOLUME 1, No. 1, pages 1 to 56, of the University of California Publications: Contributions of the Los Angeles Astronomical Department, was issued on December 26 from the University of California Press. The board of editors of the new series consists of the three permanent members of the department, Dr. Joseph Kaplan, Dr. Samuel Herrick, Jr., and Dr. Frederick C. Leonard, as chairman. Volume 1, No. 1, is entitled, "The Laplacian and Gaussian Orbit Methods," and is by Dr. Samuel Herrick, Jr. This series is designed to contain all papers originating in the department of astronomy at Los Angeles that are to appear in the publications of the University of California.

CHARLES STARLING CHILDS, '91, and Edward C. Childs, '28, have presented to the School of Forestry of Yale University a new site for its summer camp in the Great Mountain Forest in Norfolk and Canaan Townships.

THE Oklahoma State Planning and Resources Board has granted to the University of Oklahoma a ninety-nine-year lease on a three hundred-acre tract on the south side of Lake Murray for a summer camp of the School of Geology of the university. It is said that there are few places in North America where such a diversity of geological features may be observed in so small an area as that within a 25-mile radius of the new site. For more than twenty years a summer field course in geology has been conducted in the region. It is expected that instruction will be carried on throughout the entire summer under a group of instructors to be chosen from the various colleges and universities participating. Dr. A. J. Williams will represent the University of Oklahoma. The School of Geology of the university will maintain control and instructional supervision of the camp, but its facilities will be made available to any one interested in the purpose of the camp.

# DISCUSSION

## GENERAL OR SPECIAL IN THE DEVELOPMENT OF MATHEMATICS

MODERN mathematical advances are largely based on generalizations, and this has naturally led to an emphasis on what appears to be general in modern mathematical publications. It is not always observed that the generalizations of the earlier special cases are largely due to the fact that these cases are really more general than was at first observed so that their appearance as special was often due to a lack of foresight on the part of those who regarded them as special. For instance, when H. Cardan (1501–1576) included in his now famous "Ars Magna" (1545) the solution of a special quadratic equation having complex roots he took a very fruitful step forward, even if his later work seems to justify the view that this solution was not original with him. It inspired work which several hundred years later became the core of various fundamental developments.

The normal way in which mathematics has been developed is from the special to the more general, and hence it is somewhat striking that many are now inclined to dismiss various contributions merely on the ground that they are special. The much more important and more difficult question is whether they are apt to be fruitful. In the past various writers have purposely confined their remarks to the main points for the sake of simplicity and left to the reader obvious generalizations. For instance, at the close of his "La Géométrie" (1637), R. Descartes said, "I hope that posterity will judge me kindly, not only as to the things which I have explained, but also as to those which I have intentionally omitted, so as to leave to others the pleasure of discovery." In view of the very wide scope of the mathematical work at present nearly every individual contribution may reasonably be regarded as special, even when it is clothed in very general terms.

In the development of mathematics the pre-Grecian work is almost entirely concerned with the consideration of special cases, while Greek mathematics as it is represented by the "Elements" of Euclid (about 300 B.C.) is largely devoted to the consideration of general cases. This generalization in Greek mathematics does not extend as far back as was formerly supposed. The widely praised Greek rigor in geometry does not extend as far back as Pythagoras (about 580–501 B.C.) but began about a century later, according to recent critical studies of the ancient Greek mathematical literature. The systems of postulates as they have come down to us through Euclid's "Elements" seem now to be due to Euclid himself. In particular, they do not appear in the works of Aristotle, who was about twenty years older than Euclid and frequently referred to mathematics.

Notwithstanding the fact that the pre-Grecian mathematicians confined themselves almost entirely to the consideration of special cases in their extant publications, they developed one of the most fruitful abstract concepts, *viz.*, the concept of abstract numbers. It is not known that they formulated a definition of such numbers or emphasized the distinction between abstract and concrete numbers, but their use of abstract numbers is fully established. Just as abstract groups are now commonly called general groups, so abstract numbers may be regarded as general numbers in comparison with the more special concrete numbers. The ancient Egyptians are now known to have had the concept of general rational fraction, even if their publications mostly involve unit fraction. The special and the general therefore extend through the entire mathematical literature and both have been very fruitful.

The pre-Grecian rules that the area of a rectangle is equal to the product of two of its adjacent sides and that the volume of a rectangular parallelepiped is equal to the product of its three concurrent edges represent very fruitful general concepts. They exhibit the use of square units having linear units as edges

and the use of cubical units having square units as their faces, and hence they establish numerical relations between entities of different dimensions. In fact, the ancient Babylonians used certain equations whose terms represent different dimensions. The developments of number and form are thus seen to have partly united long before the work of R. Descartes and others during the seventeenth century. The deep study of mathematical history tends to exhibit a much more gradual development of our subject than is commonly exhibited in the brief accounts which usually emphasize unduly the work of a few outstanding individuals.

G. A. MILLER

UNIVERSITY OF ILLINOIS

## ILLUSIONS IN PRINTED MATTER

THERE may be "nothing new under the sun" but only something new to the writer of this note. For that reason he is recording an observed phenomenon to discover whether others have also experienced it, perhaps long, long ago.

If typewritten copy is produced with the original form on thin or "onion-skin" paper and the carbon copy on similar paper, thus usually making the second copy blacker than the first and if this copy is "single spaced," preferably, but not necessarily, with no paragraph separations, or better yet, without paragraphing, the materials are supplied for an interesting perception. The top sheet should be rotated over the lower sheet to the left or to the right to the extent of an angle no greater than about 20°, but without displacement in any other manner. An angular rotation of 5° appears to be optimal under the conditions tested.

The blank spaces between words, and to some extent the dark blocks made by the words, will form ten or twelve concentric circles like ripples on the surface of a pond into which a pebble has been cast. In the present psychobiological state of the writer, these rings did not seem to move, but the center or focus of the rings can be made to move in a direction at right angles to the line of displacement of the top sheet.

While the phenomenon appears to be illusory, because the printed words and spaces are obviously of different lengths, the circles seem to be by measurement about one centimeter in increment of radius from center to periphery. The other illusory feature is, of course, the completion of the circumferences in the perception of the concentric circles: only intermittent cues from the spaces between the words are physically furnished or, putting it obversely, many printed words obstruct or interrupt the smooth course of the spaces.

It also remains to be explained why a slight shift of about 5° around an axis should produce fairly complete circles, or at least partial circles, if the axis lies close to any one of the margins on the paper.

This brings to mind several other illusions observed in printed matter. Years ago a matter was referred to the writer concerning the bad alignment of a printed "letter-head" containing at the beginning of the address a number of 4's, thus

American Sawdust Company
4440 Austin Boulevard
Chicago, Illinois

A complaint had been registered with the printer regarding the improper assembly of the second line with respect to the first and third lines, so that the line in question seemed to be tilted downward at the left end. It was easy to show that the effect was due to the diagonal direction of the left portions of the three 4's, well known to psychologists as the Zöllner illusion and related also to the figures of Hering and Wundt. If the 4's had been printed in the type face which includes the script form, this difficulty would have been obviated.

A similar effect is noticed in those typewriters that include a triangular bracket to the right of the writing point into which a pencil is to be inserted for drawing horizontal lines on the paper moved by the carriage when released from one side to the other. Often the line, which has been typed half-way across the paper, appears to be dropping gradually to the right. The slanting side of the triangle is responsible in a similar way to the above for the distortion of the line away from its parallel relationship to the other lines.

CHRISTIAN A. RUCKMICK

C. H. STOELTING COMPANY,
CHICAGO, ILL.

## CATALOGUE OF NORTH AMERICAN EARLY TERTIARY FOSSILS OF THE GULF AND ATLANTIC COASTAL PLAIN

THIS catalogue is prepared in a manner similar to the "Catalogue of North American Devonian Fossils" published by the Wagner Free Institute of Science in Philadelphia.

The Early Tertiary catalogue will contain descriptions and illustrations of the fossil invertebrates from the Paleocene, Eocene and Oligocene of the Atlantic and Gulf Coastal Plain of the United States. Each species will be described and illustrated on a card of heavy paper 8½ by 11 inches in size, fitting a letter file. The text of the cards will be printed; the figures will be printed by full-tone collotype process. Type specimens will be figured if available; if not, photographs of topotypes will be used wherever feasible. Photographs of topotypes will be used extensively as supplementary illustrations. Original descriptions will be quoted in every case. Additional remarks or complete redescriptions will be given where necessary.

Type localities and stratigraphic data have been checked in the field by specialists in nearly all cases and will be given explicitly and in an up-to-date manner. Therefore, the cards will contain much more information than is available in the literature to-day.

There will be running numbers for the whole catalogue, one for each card. These numbers will begin with 1 and continue as long as new catalogue cards are being published. Also, there will be running numbers restricted to each class. Thus the class Gastropoda will have its own numbering apart from the numbers for the entire catalogue. The numbers will make it easy to arrange the cards and to refer to them in the literature.

The following cards are ready for publication:

Tetrabranchiate Cephalopoda (Nautiloidea)
28 species on 43 cards
Gastropoda—Genera Cryptochorda and Lapparia
12 species on 12 cards
Gastropoda—Family Turritellidae
81 species on 81 cards
Brachiopoda
27 species on 28 cards

The cards may be obtained from the Bureau of Economic Geology, Austin, Texas. Any further information will be furnished gladly.

H. B. STENZEL,
*Editor of the Catalogue*

# SPECIAL ARTICLES

## PRODUCTION FROM SUCROSE OF A SEROLOGICALLY REACTIVE POLYSACCHARIDE BY A STERILE BACTERIAL EXTRACT

THIS report deals with the production from sucrose of a serologically reactive polysaccharide by an enzyme or some similar heat labile principle contained in sterile filtered extracts prepared from cultures of *Leuconostoc mesenteroides*. The possibility that polysaccharides possessing serological properties might be synthesized from the proper substrates by enzymes obtainable from appropriate bacteria would seem indicated by the recent proof of the enzymatic syntheses of glycogen and of starch. The production of gum-like material from sucrose by sterile preparations derived from various species of spore-forming bacilli has been reported by others.[1] But in these earlier studies the products were not identified chemically nor tested serologically, whereas in our studies the product formed by the enzyme or active principle has been proved to be an immunologically reactive polysaccharide similar in both chemical and serological properties to the product formed in cultures of the living bacteria.

*Leuconostoc mesenteroides*, which is a Gram-positive coccus widely distributed on plants, seemed especially suitable for the investigation because the production of reactive polysaccharide by these bacteria can be referred to a known constituent of the medium: not only are abundant amounts formed apparently only in the presence of sucrose, but also the polysaccharide product (dextran) has been proved[2] to be composed entirely of units (glucose anhydride) which sucrose could supply. An additional advantage was that the leuconostoc polysaccharide was not only recognizable by its chemical properties but could also be identified by its capacity to react with the antiserums of types 2 and 20 pneumococci[3] as well as with the antiserum of the homologous bacteria.

We have not yet obtained the active principle entirely free of preformed polysaccharide. However, although more highly purified extracts would be desirable, the present ones are adequate to establish the general mechanism of the reaction and to permit the isolation of the purified polysaccharide product for chemical as well as serological study.

During the past 12 months 14 different lots of leuconostoc extract have been tested and all were found to have the capacity to form the reactive material from sucrose. The extracts had been filtered through Berkefeld W candles and had been subjected to rigorous tests for sterility. Aseptic technique was used in the preparation and subsequent handling of all the enzyme-substrate test mixtures, and their sterility was controlled at appropriate intervals during the incubation periods by microscopic examination and by culture in a series of liquid and solid mediums which were known to be adequate for detection of small numbers of leuconostoc bacteria. As a result of these controls we feel certain that the observed reactions occurred in the absence of microorganisms. The results of the tests of the isolated polysaccharide and a description of the preparation of the extracts, together with data on the influences of temperature and of pH and on the serological differences in the products yielded by extracts prepared from different strains of leuconostoc will be given in a later paper now in preparation.

The substrate specificity and the general mode of action upon sucrose can be illustrated by the data on

[1] M. W. Beijerinck, *K. Akad. v. Wetensch.*, Amsterdam, Proc. sect. sc, 12: 635, 1910; F. C. Harrison, H.L. A. Tarr and H. Hibbert, *Canadian Jour. Research*, 3: 449, 1930; L. Dienes, *Jour. Inf. Dis.*, 57: 12, 22, 1935.

[2] F. L. Fowler, I. K. Buckland, F. Brauns and H. Hibbert, *Canadian Jour. Research*, 15 B: 487, 1937; S. Peat, E. Schluchterer and M. Stacey, *Jour. Chem. Soc.*, 581, 1939; W. Z. Hassid and H. A. Barker, *Jour. Biol. Chem.*, 134: 163, 1940.

[3] J. Y. Sugg and E. J. Hehre, unpublished manuscript.

TABLE I

SUBSTRATE SPECIFICITY AND KIND OF ACTION ON SUCROSE

| Test conditions | Test mixture | Properties of test mixtures after incubation: Opalescence | Serological reactivity[1] | Precipitation with 1.25 volumes of alcohol[2] | Reducing sugars mg/cc | Properties of solutions of the material precipitated by alcohol: Opalescence | Reducing sugars after acid hydrolysis[3] mg/cc |
|---|---|---|---|---|---|---|---|
| 1 part extract plus 20 of substrate; incubated 9 days at 23° C. | sucrose + extract | +++ | 1000 | ++++ | 3.05 | +++ | 2.76 |
| | " + heated extract | 0 | 1 | 0 | .05 | 0 | .00 |
| | extract + water | 0 | 1 | 0 | .01 | 0 | .00 |
| | sucrose + water | 0 | 0 | 0 | .04 | 0 | .00 |
| | raffinose + extract | 0 | 5 | ± | .20 | 0 | .03 |
| | other sugars[4] + extract | 0 | 1 | 0 | – | 0 | .00 |
| 1 part extract plus 1 of substrate; incubated 2 hours at 37° C. | sucrose + extract | + | 150 | ++ | .62 | + | .52 |
| | " + heated extract | 0 | 10 | ± | .05 | 0 | .06 |
| | extract + water | 0 | 10 | ± | .04 | 0 | .05 |

[1] Highest dilution which precipitated 1:15 dilution of type 2 pneumococcus and leuconostoc antiserums after 1 hour at 37° C.
[2] Test mixture diluted 1:10 in 10 per cent. sodium acetate before precipitation with alcohol.
[3] No reducing sugars present before hydrolysis.
[4] Lactose, maltose, arabinose, xylose, galactose, dextrose, fructose and mixture of dextrose and fructose.

two representative experiments: in the first 1 part of extract plus 20 parts of various substrates were incubated for 9 days at 23° C. and in the second equal parts of extract and of sucrose substrate were incubated for only 2 hours at 37° C. The substrates were 10 per cent. solutions of the sugars in 0.1 molar acetate buffer pH 5.5 and were sterilized by Berkefeld filtration. The serological tests were made with 1:15 dilution of type 2 pneumococcus and of leuconostoc rabbit antiserums; the specificity of the reactions with those antiserums was controlled with 1:6 and 1:15 dilutions of types 1 and 3 antipneumococcus and normal rabbit serums. All the tests with the control serums were negative and are omitted from the data which are given in Table 1.

It is evident (Table 1) that when the unheated leuconostoc extract was incubated with sucrose there was a development of opalescence, of specific serological reactivity and of material precipitable with 1.25 volumes of alcohol, together with an accumulation of free reducing sugar. The alcohol precipitable material which in other analyses was proved a polysaccharide can be considered as the product responsible for the opalescence and for the serological reactivity of the sucrose-extract test mixture; the reducing sugar found in the same test mixture represents another product of the reaction. It is noteworthy that there was a close correspondence between the amount of free reducing sugars which accumulated in the test mixtures and the amount of reducing sugar obtained by acid hydrolysis of the alcohol precipitated material. This correspondence suggests that the action of the extract upon sucrose is analogous to that which has been proposed for the living leuconostoc bacteria; that is, that $X$ molecules of sucrose are converted into $X$ molecules of fructose plus a dextran polymer of $X$ glucose anhydride units.

The serological specificity of the dextran polysaccharide was indicated in these experiments by the negative reactions given by all the control serums; more detailed data on the close agreement in serological properties between the polysaccharide formed by the sterile extracts and that produced in the usual living cultures will be given in the later paper. The substrate-specificity of the active principle is indicated by the fact that with exception of the slight action upon raffinose, none of the set of phenomena which occurred with sucrose was observed with any of the other sugars which were tested.

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## ON VITAMINS IN WHEAT GERM

IN the course of our work on vitamin contents of wheat and bread, we found that wheat germ made from hard spring wheat contains a component, which stimulates the action of yeast to a greater extent than can be explained by its known vitamin contents. This was true even when the vitamins so used were present in much greater amounts than calculated from the known vitamin contents of wheat germ. A,[1] $B_1$[2] (thiamine), $B_2$ (riboflavin), PP (nicotinic acid) and E (tocopherol) are known to be present in wheat germ. All these were tried in comparative experiments, although the effects of A and E, both being fat-soluble, seem of no interest in this connection. In

[1] Through the courtesy of American Chlorophyll Company.
[2] Through the courtesy of Merck and Company, Inc.

addition, the following were also used similarly: calcium pantothenate (dextrorotatory),[3] a pyrimidine component of $B_1$ (2-methyl, 5-ethoxymethyl, 6-amino pyrimidine) and vitamin $B_6$ hydrochloride.[4]

The wheat germ used was highly purified (about .5 per cent. of wheat grain) and contained per gram 24γ$B_1$ and 7.5–10γ$B_2$.[5] The equipment and general procedure was similar to that already described for oxydase determinations.[6] Reactions were carried out in apparatus similar to that already described.[7] It differed from it in having three compartments, one for the yeast suspension, one for the nutrient solution[8] and one for the vitamin solution or the wheat germ extract.[9] The apparatus was provided with glass hooks, both on the top and bottom parts of the ground joint. Rubber bands held the two parts together and made pressure measurements possible.

1 cc of a .4 per cent. yeast suspension and 1 cc of the nutrient solution were used in all the experiments. Of the vitamin-containing solutions, .2 to 1 cc were used and additional $H_2O$ to bring the volume to 1 cc. The total volume of the apparatus, exclusive of the monometer tube, was 15 cc, leaving 12 cc of air space. Thus at 31.0° C. (the temperature of the thermostat) an increase of 1 millimeter of mercury pressure represents very closely .028 milligrams of $CO_2$. Rate of shaking was two complete excursions per second. Shaking was interrupted at 15-minute intervals for reading. A typical experiment is given.

| | | | | |
|---|---|---|---|---|
| Nutrient solution | 1.00 cc | 1.00 cc | 1.00 cc | 1.00 cc |
| Yeast suspension .4 per cent. | 1.00 cc | 1.00 cc | 1.00 cc | 1.00 cc |
| Wheat germ extract .5 per cent. | | .20 cc | 1.00 cc | |
| Vitamin A | | | | 40 units |
| Wheat germ oil (E) | | | | .01 cc |
| Vitamin $B_1$ | | | | 1 γ |
| Vitamin $B_2$ | | | | 50 γ |
| Vitamin PP | | | | 10 γ |
| Additional $H_2O$ | 1.00 cc | .80 cc | | .60 cc |
| After 150′ of shaking mm of pressure | 72 | 90 | 148 | 78 |
| Mg of $CO_2$ produced | 2.016 | 2.520 | 4.144 | 2.184 |
| Increase due to addition | | 25 per cent. | 106 per cent. | 8 per cent. |

It appears that wheat germ contains a water-soluble heat-stable component, which stimulates yeast cells to greater activity in a manner usually attributed to vitamins. The effect is much greater than that of other vitamins studied. It may be due to a single or a mixture of essential food factors as yet not recognized.

This effect becomes particularly significant because nutritional authorities are endeavoring to establish certain levels for vitamins in flour and bread. It is expected that flour would contain 1.6 mg of thiamine, 1.2 mg of riboflavin, 10 mg of nicotinic acid and approximately 20 mg of iron per pound.[10] The additions would be made to offset the removal of vitamins by depriving the wheat of the wheat germ. The discovery here outlined may lead to making the reconstitution of the flour more complete.

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[3] Through the courtesy of Dr. R. R. Williams.
[4] Through the courtesy of Dr. K. G. Falk.
[5] Determinations made by Dr. D. J. Hennessey, of Fordham University.
[6] Bul. No. 238, B.P.I., U. S. Dept. of Agriculture, 1912.
[7] *Jour. Biol. Chem.*, XVII, p. 409, 1914.
[8] A. J. Schultz, L. Atkin and C. N. Frey, *Jour. Am. Chem. Soc.*, 59: 2547, 1937.
[9] Catox apparatus can be secured from Palo-Myers, Inc., New York City.
[10] Personal communication from Dr. Russell M. Wilder, chairman of the Committee on Food and Nutrition, National Research Council.

# SCIENTIFIC APPARATUS AND LABORATORY METHODS

## A METHOD FOR MAKING SNOWFLAKE REPLICAS

THE exquisite beauty and infinite variety of the snowflake described in the early writings of Tyndall and others was brought to popular attention by the pioneer crystallographic work of Wilson A. Bentley, whose photomicrographs of snowflakes are classic in this field of study.

The technique of photographing snowflakes, while not exceedingly difficult, is rarely attempted because of the equipment needed and the essential factor that camera, slides, microscope and other apparatus must be kept below 0° C.

The technique for preserving snowflakes is extremely simple. A strip of velvet, or other dark material, fastened to a board or table, a few glass microscope slides, a toothpick or wire and a weak solution of a suitable resin are all the equipment necessary. The only other essential detail is an occasional snow flurry. The above-mentioned material is kept outdoors in a sheltered place ready for appropriate precipitation.

As soon as a suitable flake is observed on the dark background a drop of solution is placed on the glass slide with the toothpick or wire, and the flake is lifted with the same tool and placed in contact with the drop.

The solution should wet the flake completely. A second drop placed on top of the snowflake is sometimes desirable, particularly if the flake has large proportions. After wetting the flake in this manner the solvent soon evaporates, leaving the snowflake encased within a shell of resin.

A 1 per cent. solution of polyvinyl formal resin designated as Formvar 15–95 dissolved in ethylene dichloride and cooled below 0° C. was found to produce excellent replicas. The thickness of such a replica is of the order of 20,000 Å U.

As soon as the solvent has evaporated, the slides may be removed to a warm place. The case may be protected from abrasion by covering with a transparent sheet of resin or a glass coverslip or slide.

Because of the simplicity of this technique the casting materials can be carried anywhere, thus greatly increasing the possibilities of obtaining unique specimens.

A slight modification of the method provides an equally easy way to make a permanent record of breath patterns and any other structures, such as frost crystals, hoar frost and similar perishable formations.

When molecular films are deposited on the plate, it is placed in the freezing compartment of a refrigerator, and upon cooling to about 10° C. is held for a brief moment in the presence of moist air (which forms the so-called "breath patterns"), replaced in the ice chamber and the condensate is frozen. Meanwhile the 1 per cent. solution is cooled below 0° C. The plate containing the frozen breath pattern or other formation is then dipped into the solution, removed and returned to the cold chamber until the solvent evaporates. A perfect replica remains after the plate is warmed and the water evaporates.

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## THE USE OF INFRA-RED FILM FOR ELECTROPHORETIC AND ULTRACENTRIFUGAL ANALYSES

OPTICAL analysis in the air-driven ultracentrifuge or the Tiselius electrophoresis or diffusion apparatus is usually carried out in the visible region with some modification of the Töpler Schlieren method. Ultraviolet light, formerly employed for the examination of protein solutions by absorption recordings, is generally unsuited for the newer optical systems because of the expensive quartz lenses required.

We have encountered some difficulty in examining certain systems, particularly protein solutions containing dyes or bacterial pigments, because of their opacity to visible light. In overcoming this, advantage has been taken of the fact that many substances which absorb markedly in the visible region are transparent in the near infra-red. Thus even a deep brown solution of iodine in carbon tetrachloride is freely transparent to certain infra-red rays.[1]

The only modifications required in the new procedure are infra-red sensitive photographic films or plates, and a good source of infra-red radiation, such as a Nernst lamp, although satisfactory results can be obtained with an ordinary tungsten lamp. Infra-red plates and films are only slightly more expensive than panchromatic materials and can be obtained in a wide variety of sizes. They can be used in most cameras and plate holders although occasionally an older model may be found which is not infra-red "tight," with consequent general fogging. Theoretically, the focal length should be increased about 2 per cent. for infra-red work,[2] but in practice we have obtained sharp boundaries through visually opaque solutions without any disturbance of the usual focus of the ultracentrifuge or electrophoresis optical system.

As certain infra-red sensitized films and plates are sensitive to visual blue and red as well, filters may be necessary if the recording is to be made solely by infra-red radiation. In most cases the solution to be examined will serve as the filter. Exposures made by infra-red light alone should be longer than for the visible region. Development and fixation are conducted as for panchromatic materials.

Our experience has been limited to the plates and films used in amateur photography, sensitized up to 8600 Å—an extension of 1600 Å above the visible red. Although these have proved satisfactory for our purposes the possibility exists that solutions might be encountered which absorb in the region 7000–8000 Å as well. For these some of the special far infra-red sensitized plates available may be indicated.

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[1] R. W. Wood, "Physical Optics," p. 15, New York: Macmillan, 1934.

[2] "Infrared Photography with Kodak Materials," Eastman Kodak Company, 1940.

## BOOKS RECEIVED

*Blood Transfusion Association. Report, 1940–41; Project for Supplying Blood Plasma to England.* Pp. iv+121. The Association, New York.

SCHUCHERT, CHARLES and CARL O. DUNBAR. *A Textbook of Geology. Part II—Historical Geology.* 4th edition, revised. Pp. xiii+544. 343 figures. Wiley. $4.00.

SHERRINGTON, SIR CHARLES. *Man on His Nature.* Pp. 413. 12 plates. Cambridge University Press, Macmillan. $3.75.

SIGERIST, HENRY E. *Medicine and Human Welfare.* Pp. xiii+148. 20 figures. Yale University Press. $2.50.